Anatomy Physiology and Hygiene

F. Franklin Smith

TEXT-BOOK

OF

ANATOMY, PHYSIOLOGY

AND

HYGIENE

BY

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TO

CHARLES WARRENE ALLEN

WHOSE MANY ACTS OF KINDNESS ARE GRATEFULLY REMEMBERED

THIS MODEST LITTLE VOLUME

IS RESPECTFULLY DEDICATED BY

THE AUTHOR

PREFACE.

The educational systems of the present time fully recognize that nothing can be of more importance to our comfort, our usefulness, or even our mental improvement, than a knowledge of the structure of the body and of the fundamental laws of health. As lecturer on Anatomy, Physiology, and Hygiene, my connection for several years with the New York Preparatory School, whose special work is the preparation of students for admission to the study of certain professions for which the New York laws require the completion of satisfactory work in a registered high school, or its equivalent, has indicated a need for a work on this subject a little different from any on the market. This volume is practically an epitome of the author's lectures; and, while it lays claim to little originality, it is thoroughly in accord with the most advanced authorities, and is systematized and classified, so as to enable the student to acquire a thorough and scientific knowledge of the subject in a comparatively short time.

As physiology is less of a disciplinary and more of an informatory study than other sciences of the same category, as botany, zoology, etc., the instruction should follow the objective method so far as possible. Microscopic study of finer tissues should be introduced whenever practicable. A manikin is of invaluable aid. Rough dissections should be made; material for this work can be obtained from any butcher's shop.

Charts should be frequently referred to. The value of the objective method of studying anatomy and physiology cannot be overestimated.

While the work is a little more extended than the majority of school text-books on this subject, every endeavor has been made to avoid technicalities, and a glossary containing an accurate definition of a large number of the medical terms used will, no doubt, add much to the usefulness of the work. For the preparation of this glossary the author wishes to give due credit to Foster's Encyclopædia of Medicine.

In the preparation of the illustrations the following works have been freely copied from : Gray's "Anatomy," Kirke's "Physiology," Waller's "Physiology," Tracy's "Physiology," Flint's "Physiology," Doty's "Prompt Aid to the Injured," Wise's "Text-Book on Nursing."

I wish to acknowledge my indebtedness to the following writers for much of the material used in the book : Flint, Dalton, Wilson, Pye, Kobert, Rohé, Treves, Tracy, Doty, Wise, and especially Kirke.

E. FRANKLIN SMITH, M. D.

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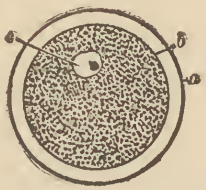
MINUTE STRUCTURE OF THE BODY.

All the tissues and organs of which the body is composed, consist of fundamental structural elements, termed *cells*, and of an *intercellular substance*.

Cells.

Every cell making up the higher organism of animal life, consists of *protoplasm*, imbedded in which is a small body termed the *nucleus*. Inside the nucleus is frequently seen a minute body, called the *nucleolus*. A *limiting membrane* often surrounds the cell.

Fig. A.



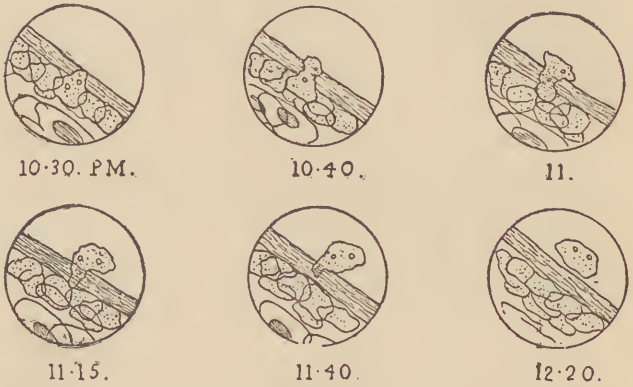
A single cell.—*a*, the limiting membrane; *b*, protoplasm; *c*, nucleus, imbedded in which is the nucleolus.

Protoplasm is a soft, granular material; it is semi-fluid, of viscid consistence, and homogeneous. The most striking characteristics of protoplasm are its vital properties of *motion* and *nutrition*.

By *motion* is meant the power which protoplasm has of changing its shape and position; it thrusts out from its main body an irregular process, into which the whole of the protoplasmic substance is gradually

drawn, so that the mass occupies an entirely new position. This is sometimes referred to as "amaboid movement." (See Fig. B).

Fig. B.



Illustrating the stages of the migration of a single white blood-corpuscle through the walls of a vein in two hours and ten minutes. (Caton).

By *nutrition* is meant the power that protoplasm has of attracting to itself the materials of growth from surrounding matter.

A nucleus is a minute body, imbedded in the protoplasm, and usually of a spherical or oval shape, generally placed near the center of the cell, and may be single or multiple. (See Fig. A, c.) This is that part of the protoplasmic substance set apart for the purpose of reproduction, by division of the cell.

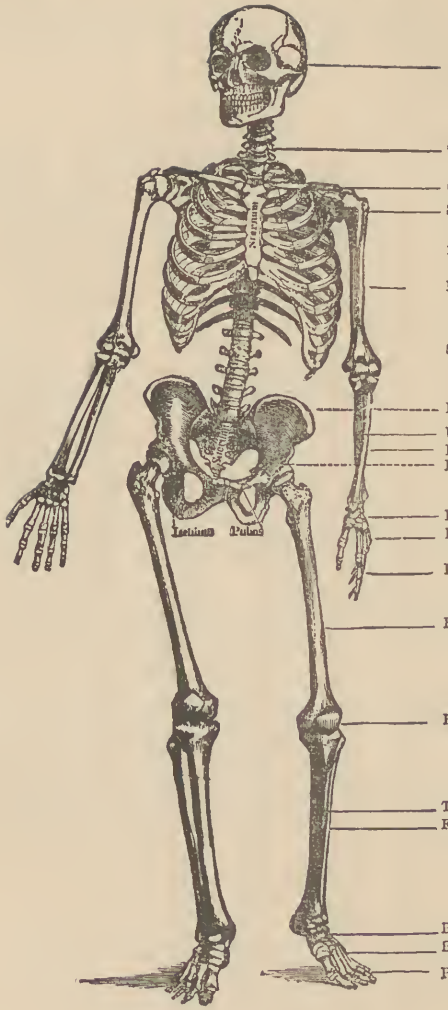
Intercellular Substance.

The intercellular substance is necessary to retain the cells in position; it may be very small in amount, as in the case of epithelium, where it is merely

sufficient to cement the cells together; or it may be very much greater, as in the case of cartilage, where it forms a matrix in which the cells lie at some distance from each other.

Vital Activity, or Vital Energy.

Cells take in food, grow, excrete, perform certain functions, of which motion is the most obvious, and reproduce. This is termed *vital activity* or *vital energy*, and is naturally the first essential to living. There are muscle-cells to produce motion, gland-cells to secrete and excrete, and nerve-cells to control the working of muscles, glands, and perhaps other tissues; certain cells are set apart for reproduction; and there are connective tissues to unite and support the other structures, and surface epithelium to protect them. Blood carries prepared food-stuffs to the capillaries, where they pass out with the lymph to come into actual contact with the cells; certain of these bodies are taken up and become part of the substance of the cell, replacing other material which has been broken down to supply force for assimilation and all other actions of the cell. This breaking-down of cell-substance consists in its union with oxygen obtained from the blood. All such oxidation takes place in the cells, *not* in the blood; so it is necessary that all food should become part of the cell before it is oxidized.


Cranium
7 Cervical Vertebræ
Clavicle.
Scapula.
12 Dorsal Vertebræ.
Humerus.
5 Lumbar Vertebræ.
Ilium.
Ulna.
Radius.
Pelvis.
Bones of the Carpus.
Bones of the Metacarpus.
Phalanges of Fingers.
Femur.
Patella.
Tibia.
Fibula.
Bones of the Tarsus.
Bones of the Metatarsus.
Phalanges of Toes.
Sternum
Ischium
Pubes

ENUMERATION OF THE BONES.

SKULL:	Cranium:	Occipital (back of head)			
		2 Parietal (sides of head, above)			
		2 Temporal (sides of head, below)		8	22
		Frontal (forehead)			
		Sphenoid (at base of skull)			
		Ethmoid (base of skull)			
	Face:	2 Superior maxillary (upper jaw)			
		Inferior maxillary (lower jaw)			
		2 Malar (cheek-bones)			
		2 Lachrymal (part of the orbit)		14	
		2 Nasal (bridge of nose)			
		2 Inferior turbinated (insido of nose)			
		2 Palatal (at back of nose)			
		Vomer (part of partition of nose)			
Hyoid bone, at base of tongue				1	
SPINE:	Cervical vertebræ (in the neck):	Atlas (next to skull).			
		Axis		7	26
		5 others			
	Dorsal vertebræ (supporting the ribs)			12	
	Lumbar vertebræ (in small of back, or loins)			5	
	Sacrum (These bones, together with the hip-bones, form the *pelvis*.)			1	
	Coccyx (These bones, together with the hip-bones, form the *pelvis*.)			1	
RIBS (12 on each side)				24	
STERNUM (breast-bone)				1	
UPPER EXTREMITY:	Clavicle (collar-bone)			1	64
	Scapula (shoulder-blade)			1	
	Humerus (upper-arm)			1	
	Radius (forearm)			2	
	Ulna (forearm)				
	Carpal bones* (wrist):	Scaphoid, semilunar, cuneiform, pisiform, trapezium, trapezoid, os magnum, unciform		8	
	Metacarpal bones (hand)			5	
	Phalanges (thumb, 2; fingers, 3 each)			14	
LOWER EXTREMITY:	Os innominatum (hip-bone)			1	62
	Femur (thigh-bone)			1	
	Tibia (shin-bone) (leg)			2	
	Fibula (leg)				
	Patella (knee-pan)			1	
	Tarsal bones (ankle):	Calcaneum or os calcis (heel-bone), astragalus, cuboid, scaphoid, internal, middle, and external cuneiform		7	
	Metatarsal bones (foot)			5	
	Phalanges (great toe, 2; other toes, 3 each)			14	
Total†					200

* Beginning at thumb-side of wrist in each row.

† The minute bones of the ear, 3 on each side, are sometimes included in the list of bones, making 206. The teeth (20 temporary and 32 permanent) are not bones.

I.—FRAMEWORK OF THE BODY.

The entire skeleton in an adult consists of 200 distinct bones.

The Function of Bones.

1. To act as levers.
2. To protect delicate organs.
3. To form a framework for the body.

Classification.

1. Long Bones, which form a system of levers. A long bone consists of a *shaft* and two *extremities*. The *shaft* is a hollow cylinder, contracted and narrow to afford greater space for muscles. The wall consists of dense compact tissue. The interior is hollowed to form a *medullary* canal. The *extremities* are expanded for purposes of articulation and to afford a broad surface for the attachment of muscles. Important long bones are the *clavicle*, *humerus*, *radius*, *ulna*, *femur*, *tibia* and *fibula*.

2. Short Bones. These are found where great strength and compactness are needed, and where motion is slight, as in the *carpus* and *tarsus*.

3. Flat Bones. These are found where extensive protection or broad surfaces for the attachment of muscles are needed. Examples are to be found in the bones of the *skull*, *scapula*, *os innominatum*, *sternum*, *ribs* and *patella*.

4. Irregular Bones. These bones cannot be classed under either of preceding heads on account of

their peculiar forms. Examples are to be found in the *vertebræ*, *sacrum*, *superior maxilla* and *inferior maxilla*.

Structure and Physical Properties of Bone.

Bone is one of the hardest structures of the human body. It is tough and elastic. Its color, in the fresh state, is pinkish-white externally and deep red within. On examining a section of bone it will be found to consist of two kinds of tissue, one of which is dense and *compact* in texture; the other, from its resemblance to a lattice-work, is called *cancellous*. The compact tissue is always found on the outside of the bone, while the cancellous is always internal. The difference in structure between the two depends upon the different amounts of solid matter and the number of spaces in each.

Fig. 1.—The right femur, or thigh bone, sawn in two lengthwise; showing arrangement of compact and cancellous tissues.

Periosteum surrounds bone almost everywhere except at its cartilaginous extremities. By means of the periosteum blood-vessels reach the hard tissue. If the periosteum be torn off from the surface of a living bone, small bleeding points are seen, which mark the entrance of blood-vessels. If this membrane be denuded, death of bone, or *necrosis*, usually occurs.

Marrow fills the cylindrical shaft of long bones. Here it is of a *yellow* color and contains about 96 per cent. of fat. Marrow is also found in certain flat and short bones, where it is of a *red* color, and a mere trace of fat is found.

Minute Anatomy of Bone.

Under the low power of the microscope a number of circular districts are seen, each one of which

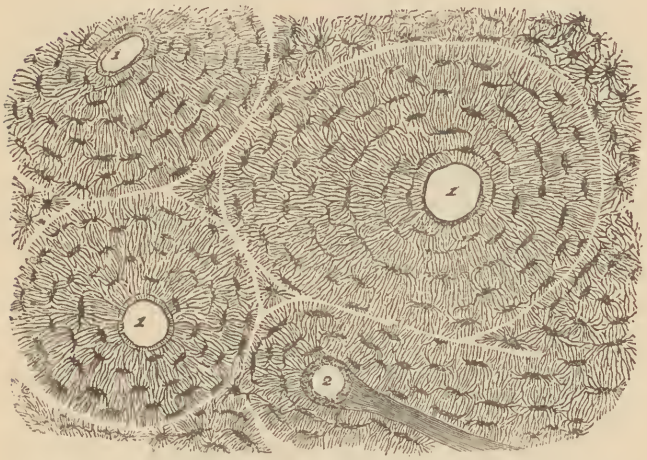


Fig. 2.—Vascular canals and lacunæ, seen in a transverse section of the humerus.—1, 1, 1, section of the Haversian canals; 2, section of a longitudinal canal divided at the point of its anastomosis with a transverse canal. Around the canals, cut across perpendicularly, are seen the lacunæ (with their canaliculi), forming concentric rings.

consists of a central hole, surrounded by a number of circular rings. These districts are termed *Haversian systems;* the central hole is an *Haversian canal*, and the rings around are layers of bone tissue arranged con-

centrically around the central canal, and are termed *Haversian lamellæ.* Between these lamellæ, and therefore arranged concentrically around the central canal, are a number of dark spaces, the *lacunæ;* these lacunæ are connected with each other and with the central Haversian canal by a number of fine dark lines, which radiate like the spokes of a wheel, and are called *canaliculi.*

Chemical Composition of Bone.

Bone consists of an animal and an earthy part intimately combined together. The former gives bone its tenacity, while the latter gives it hardness and rigidity.

Fig. 3.—Fibula tied in a knot, after maceration in a dilute acid. (From a specimen in the Museum of the College of Physicians and Surgeons.)

The animal part may be obtained by immersing the bone for a time in dilute mineral acid, after which the bone comes out exactly the same shape as before, but so flexible that, if it be a long bone like the fibula, it can be tied in a knot.

The earthy matter may be obtained separate by calcination, by which the animal matter is burned out. The bone will still retain its original shape, but it will be white and brittle, crumbling down with the slightest force.

The organic matter forms about one-third, or 33.3 per cent., and consists of gelatin, blood-vessels and fat. The inorganic or mineral matter forms about two-thirds, or 66.7 per cent.; and the principal salts are the phosphate of lime and the carbonate of lime.

The proportion of these two constituents of bone varies at different periods of life. Animal matter predominates in childhood, while in aged people there is a larger proportion of earthy matter. Hence, the bones of very young people often bend when injured instead of breaking. In old people they become so brittle that the slightest blow often causes them to break.

A "green-stick" fracture is one where the bone is bent like a green twig, only a small portion of it on the outside of the bend being broken or torn apart.

There is a disease called "rickets," common amongst the poor, in which the bones become bent and curved, due to the superimposed weight of the body and to the action of muscles. This depends upon some defect of nutrition by which the bone becomes deprived of its normal proportion of earthy matter.

Development of Bone.

At one period of life they are nearly all cartilaginous, but the cartilage is gradually turned into bone by a process which is called ossification. Ossification is usually complete by the twenty-fifth year.

Strength of Bone.

Bone is twice as strong as box, yew and oak, and it is over three times as strong as lead.

The Spine.

The Spine is a flexible column, two feet two or three inches in length. It is formed of a series of bones called *vertebræ;* these vertebræ are thirty-three in number, and are piled one upon another with a *pad of cartilage* in between each one. These pads taken together make up about one-fourth the entire length of the column; they deaden shocks to the body. During the day they become compressed, so that at night one is from one-quarter to one-half an inch shorter than he was in the morning. The vertebræ consist of a *body* and an *arch*, enclosing a canal,—the *spinal canal*. This canal transmits the spinal cord and its membranes.

Fig. 4.—The Spinal Column,—1-7, cervical vertebræ; 8-19, dorsal; 20-24, lumbar.

Viewed laterally, the spinal column presents several curves, which are named *cervical*, *dorsal*, *lumbar* and *pelvic*. The object of these curves is to prevent shock.

The Skull.

The Skull consists of bones whose principal function is that of protection. The bones immediately forming the outside of the skull and surrounding the brain are composed of an outer thick layer and an inner thin layer, and between the two is a spongy layer; this arrangement is for the purpose of deadening shock. The only movable bone in the skull is the lower jaw.

The Sutures of the Skull.

The bones of the face and the cranium are connected together by means of sutures—that is, the articular surfaces are roughened or uneven, and are closely adapted to each other, like dove-tail work. This arrangement of the sutures also tends to deaden

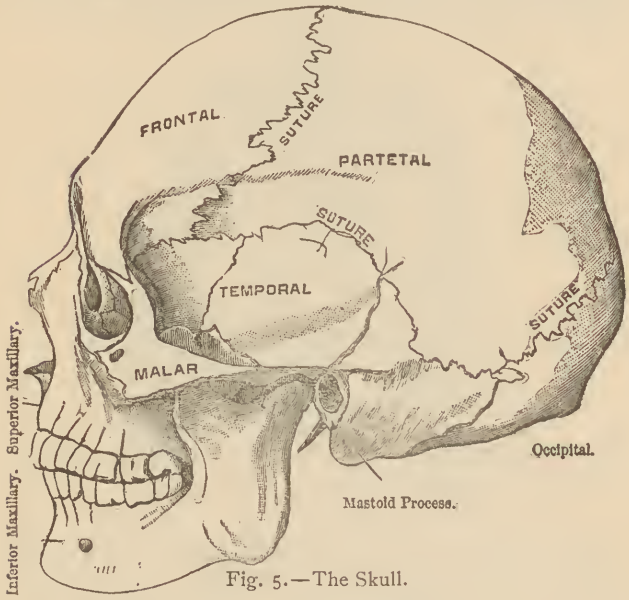


Fig. 5.—The Skull.

the shock of a blow. The principal sutures of the skull are :

1. *Coronal*, between the frontal and parietal bones.
2. *Sagittal*, between the two parietal bones.
3. *Lambdoid*, between the parietal and occipital bones.

The Frontal Sinuses.

These are two cavities situated in the substance of the frontal bone (one of the bones of

the skull). They cause the prominence over the eye-brows. These cavities are lined by a mucous membrane, and are connected with the cavity of the nose by a small canal. As a result, when one has a severe "cold in the head" the inflammation extends up this passage into the frontal sinuses, and so gives rise to the dull headache over the eye-brows.

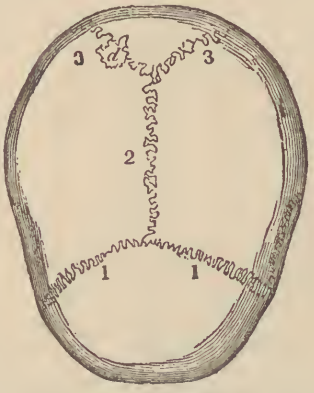


Fig. 6.—1, 1, the coronal suture at the front and upper part of the skull; 2, the sagittal suture on the top of the skull; 3, 3, the lambdoidal suture at the back part of the cranium.

The Thorax.

The Thorax is a cage made up of bone and cartilage containing and protecting the principal organs of respiration and circulation. It is bounded *behind* by twelve dorsal vertebræ and the posterior part of the ribs; in *front*, by the sternum and costal cartilages; *laterally*, by the ribs and intercostal spaces. The *floor* is formed by the diaphragm muscle. The *shape* of the thorax is conical, narrow above and broad below, but sometimes, from tight lacing, this is reversed; it is not uncommon to see the smaller end at the waist. (See fig. 9.)

The Ribs.

The Ribs are elastic arches of bone which form the chief part of the thorax. They are twelve in number on each side (twenty-four in all). The first seven are called *true* ribs, the remaining five being called *false* ribs, the last two of which are termed *floating* ribs. These ribs increase in length from the first

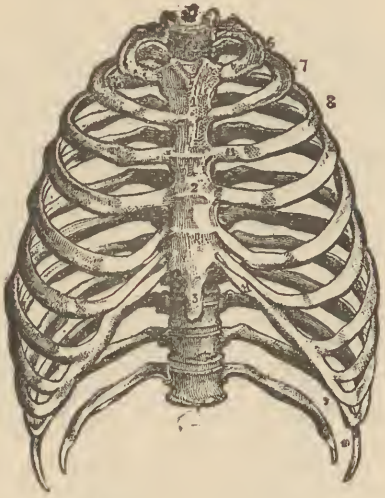


Fig. 7.—Thorax. (Sappey.)—1, 2, 3, sternum; 6, first rib; 7, second rib; 8, 8, last five sternal ribs; 9, upper three false ribs; 10, last two, or floating ribs; 11, costal cartilages.

to the seventh, and then diminish, so that the last or twelfth rib is quite short. The ribs are attached to the spine behind and to the breast bone in front in such a manner that when we take an inspiration the lateral as well as the antero-posterior diameter is increased.

The Limbs.

With but slight exceptions the bones of the upper

extremity have their counterpart in the bones of the lower extremity. Thus the bone of the arm (*humerus*) corresponds to the bone of the thigh (*femur*); those of the forearm (*radius* and *ulna*) to those of the leg (*tibia* and *fibula*); those of the *carpus* (eight in number) to those of the *tarsus* (seven in number);

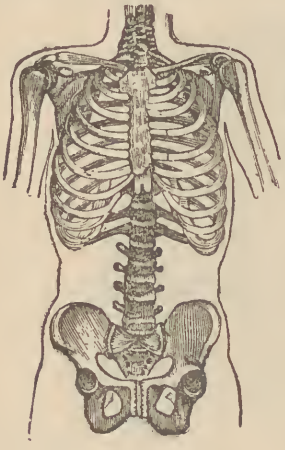


Fig. 8.—Natural and well proportioned chest.

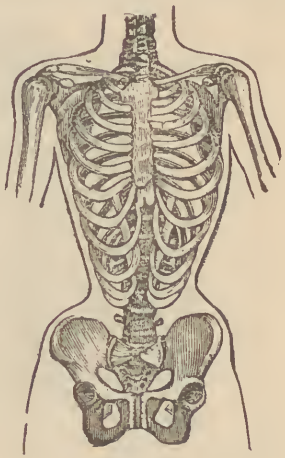


Fig. 9.—Chest fashionably formed.

those of the *metacarpal* to those of the *metatarsal* (five bones in each); the *phalanges* have fourteen bones in each of the extremities.

The Joints.

The bony surfaces which move on each other, constituting a *joint*, are bound together by strong fibrous tissue, which forms a capsule about them to prevent dislocation while it admits of the needful degree of motion. Where the strain is greatest the

fibrous tissue assumes the form of strong interlaced bands, which are called *ligaments*. The surface of the joint is not covered by periosteum, but by a firm,

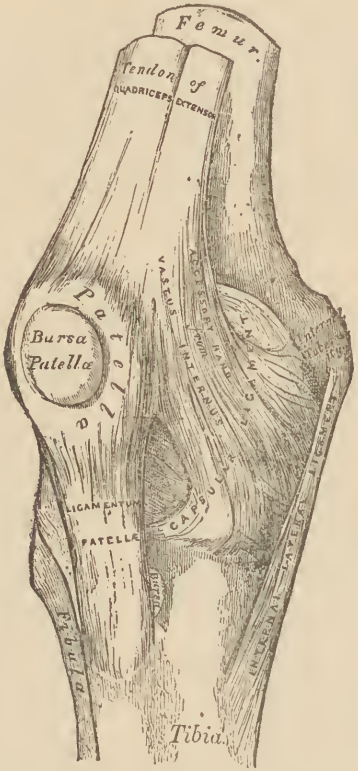


Fig. 10.—Right knee joint, showing the strong fibrous tissue which forms a capsule about it to prevent dislocation.

bluish-white, smooth and very elastic membrane called *cartilage*. The joint is entirely closed by a *synovial membrane*, which secretes a lubricating fluid called *synovia*.

Joints are divided into three classes: (1) immovable, (2) having limited motion, (3) having free motion.

Movable joints are divided into three kinds: (1) joints having a *gliding* motion, as at wrist and ankle; (2) *ball* and *socket joints*, as where a globular head is received into a cup-like cavity, and admitting motion in all directions, as shoulder and hip; (3) *hinge-joints*, where the motion is limited to two directions, forward and backward, as the elbow.

II.—MUSCLES.

Muscles are the active organs of locomotion. They produce symmetry and act as a protection. They are formed of bundles of reddish fibres endowed with the property of shortening themselves upon irritation, which is called *muscular contractility*. Muscles make up about one-half the entire body weight, and number over five hundred.

Structure and Composition.

There are two chief kinds of muscular tissue, viz.:

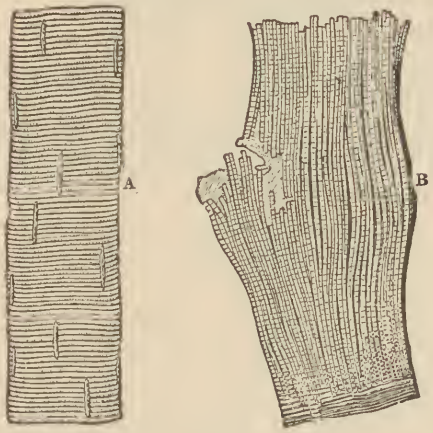


Fig. 11.—Voluntary muscular fibres. (Sappey.)—A, transverse striæ and nuclei of a primitive fasciculus; B, longitudinal striæ and fibrillæ of a primitive fasciculus in which the sarcolemma has been lacerated at one point by pressure.

1. *Voluntary*, or *striated*, which are under the control of the will. A voluntary muscle is made up

of bundles of reddish *fibres*, joined together by connective tissue. Each fibre is made up of a bundle of *fibrillæ*, which are held together in turn by a surrounding sheath called the *sarcolemma*. Under the high power of the microscope each fibril presents delicate lines running at right angles to the long axis of the fibril. These lines are called *striæ*.

Voluntary muscle constitutes the whole of the muscular apparatus of the skeleton, the walls of the abdomen, etc., the whole of those muscles which are

Fig. 12.—Muscular fasciculus showing fibres.

under the control of the will. The name of one of the broadest muscles of the body is the *latissimus dorsi;* the longest muscle is the *sartorius*, or "tailer's muscle"; the smallest, the *stapedius*. The *diaphragm* is a large muscle which separates the thorax from the abdominal cavity.

2. *Involuntary*, or *non-striated*, which are not under the control of the will. This muscular fibre consists of flattened, fusiform fibrillæ, consisting of elongated cells. They are not striated. These fibres are found in the alimentary track, walls of the blood-vessels, trachea, iris, etc.

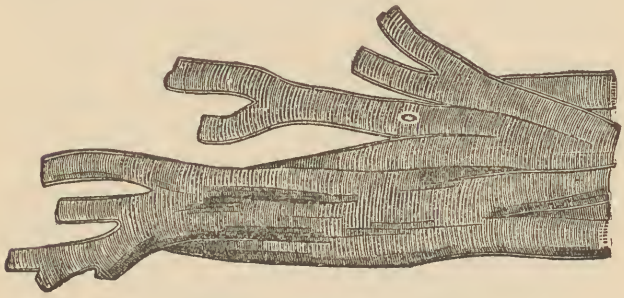
The Tendons.

At each end of a voluntary muscle the contractile fibres become blended with strong fibrous tissue, which

interweaves with the periosteum and so gives the muscular fibres a strong attachment. The strongest tendon in the body is the *tendo Achilles*, which is inserted into the heel (*os calcis*). By bringing the toes toward the shoes, this tendon can be distinctly felt.

Difference Between Voluntary and Involuntary Muscular Fibres.

A voluntary muscle is composed of striated fibres, which allow of a rapid contraction upon the receipt of a stimulus.



13.—Anastomosing fibres of the heart.

An involuntary muscle has no striated fibres, and, upon receipt of a stimulus, the contraction is slow to begin, proceeds slowly up to a certain point, when the fibres begin to relax. The contractions are similar to the slow, crawling motion of a worm or snake.

The Heart Muscle belongs to neither of the above varieties. This muscle is peculiar in that—

1. It is indistinctly striated.
2. It has no sarcolemma.
3. Its fibres branch and anastomose with each other. (See fig. 13.)

4. A minimum stimulation is followed by a maximum contraction.

5. It cannot enter into a state of tetanus.

The Phenomena of Muscular Contraction.

The power which muscles possess of contracting may be called forth by stimuli of various kinds, such as:

1. *Mechanical stimulus*, as by pinching of the muscle or the nerve which supplies it.

2. *Thermal stimulus*, as by a heated needle applied.

3. *Chemical stimulus*, as by applying dilute acids, etc.

4. *Electrical.*

5. The *normal physiological stimulus*,—that conveyed by nerves.

Accompaniments of Muscular Contractions.

1. *Heat* is developed, either from chemical changes in the muscles, from the friction of the fibres, or both.

2. *Sound* is produced.

3. *Changes in shape* occur; it appears to swell up, becoming rounder, more prominent, harder and apparently tougher.

4. *Chemical change* is noted; the reaction changes from an alkaline to an acid one, due to the development of sarcolactic acid.

5. *Electrical changes.*

Strength of Muscles.

By determining the number of pounds that an animal can drag upon a level surface, and afterwards comparing that with its own weight, we can judge its muscular force. It has been found that man is

able to drag a little less than his own weight. A draught-horse can exert a force equal to about two-thirds of its weight. The horse, therefore, though vastly heavier than man, is relatively not so powerful.

It has been estimated that the muscles of the arm (*biceps*, assisted by the *brachial anticus*) can flex it with a ten-pound weight in the hand; this contraction represents a force of about two hundred pounds, and yet a delicate woman or a child can perform this act.

The Muscular Sense.

The muscular sense is the chief means we have of determining the weight, the hardness, the smoothness, the softness, etc., of bodies; this sense is also instrumental in enabling us to keep our bodies erect.

The estimate of weight is usually based on two sensations: 1, of pressure on the skin; and, 2, the muscular sense. This is shown by the following simple experiment. If the hand be placed flat upon the table, and a somewhat heavy weight be put into it, touch alone is exercised and a feeling of pressure results; but, if the hand be raised, a certain amount of muscular effort must be put forth, and thus a sensation of weight is recognized.

Necessity for Exercise.

Healthy functions of the bodily organs can only be maintained by more or less constant use. A muscle or other organ that is unused soon wastes away, or becomes valueless to its possessor. On the other hand, trained use of the various organs make them more effective for the performance of their functions.

Exercise will do for your body what intellectual training will do for your mind,—educate and strengthen it.

Any man who does not take time for exercise will probably have to take time to be ill.

Effect of Exercise.

When a muscle contracts, the flow of blood through it is increased, which results in increased nutrition and growth of the muscle. There is also increase in the respiratory process. The action of the heart is increased both in force and frequency. Cutaneous transpiration is also promoted, so ridding the system of some of its useless or effete matter. Persons who are engaged in physical labor, other things being equal, are healthier, happier, and live longer than those whose occupations make slight demands upon their muscular system.

Forms of Exercise.

The principal forms are walking, running, rowing, swimming, and the various indoor gymnastics. Rapid walking or running is one of the best forms of exercise, for it not only increases the development of the muscles of the legs and thighs, but it also increases the capacity of the chest. It is better that exercise should be a pleasure rather than a duty; therefore the out-door sports boys are so fond of are the best; this applies to girls as well as to the boys, for it is well known that the tom-boy grows to be the most healthy and vigorous woman, mentally and physically.

Fatigue and Over-exertion.

If a muscle is exercised too much, the waste of material is greater than the supply, and it falls into a

condition which is called *fatigue*, and it then requires great effort to make that muscle perform its function. If now rest is taken, the muscle recovers very fast; but if rest be not taken, exhaustion follows, and we soon become broken down in health by this excessive strain.

It is well to bear in mind these two facts:

1. Out-door sports are more healthful than indoor gymnastic exercises.

2. Exercise may be pushed to the point of fatigue without injury, but never to the point of exhaustion.

III.—SKIN.

General Office of the Skin.

1. It is an external investment of the body, serving for the protection of its deeper layers.

2. It is a sensitive organ in the exercise of the sense of touch.

3. It is an important secretory and excretory organ.

4. It is an absorbing organ.

5. It regulates the temperature of the body.

Structure of the Skin.

The skin is composed of two layers, an outer one, the *cuticle* or *epidermis*, and an inner one, the *cutis* or *derma*. Within and beneath the derma are imbedded several organs with special functions, *sudoriferous* or *sweat* glands, *sebaceous* glands, and *hair follicles;* and on the surface are sensitive *papillæ*. The so-called appendages of the skin—the *hair* and *nails*—are modifications of the epidermis.

The *epidermis* consists of flattened, dry scales; the thickness varies in different portions of the body and is directly proportioned to the friction, pressure and other sources of injury to which it is exposed. The lowest layer of cells contains pigment which gives to the skin its varying tints in different individuals and in different races of men.

The *derma* is a dense and tough but yielding and highly elastic structure. On its under surface are found little elevations called *papillæ;* they have a free

supply of blood-vessels and contain one or more nerve fibres on which their exquisite sensibility depends. (See sense of touch.)

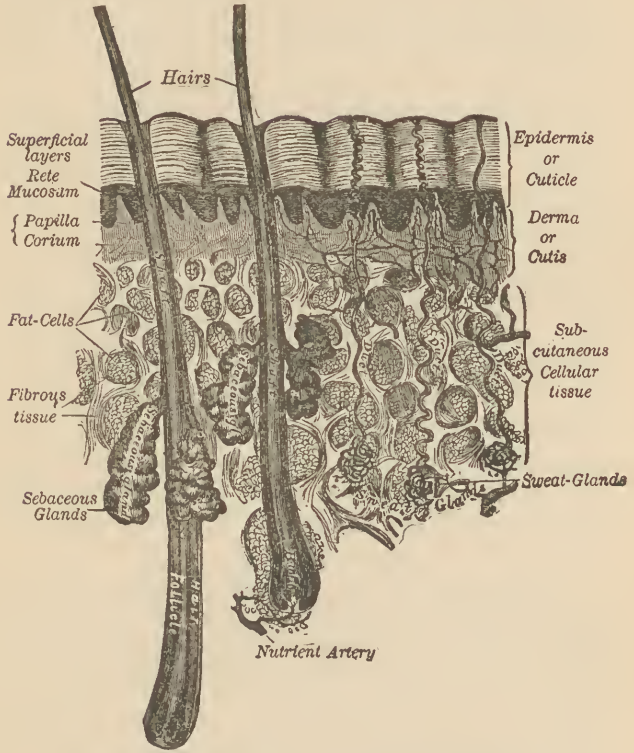


Fig. 14.—Sectional view of the skin (magnified).

Appendages of the Skin.

The *hair* covers almost the whole of the body except the palms of the hands and the soles of the feet. Its functions are (1) to protect the head from heat or

cold, (2) retain the heat of the body, (3) prevent the entrance of foreign matter into the lungs, nose, ear, etc. Hairs are composed of a *root* and *shaft*. The shaft is covered internally by cells which contain pigment material giving the hair its peculiar color. The root of the hair is imbedded in the hair follicle, formed by a tubular depression of the skin. The *nails* grow from a fold of the cuticle, and this part is called the *matrix*. The back edge of the nail is called the *root*, and is received into the matrix. The nails assist the delicacy of touch.

The *sebaceous* glands are imbedded in the derma, their ducts opening upon the surface of the skin, or into a hair follicle. A peculiar oily matter, the *sebum*, is secreted, which serves the purpose of lubrication to both skin and hair. These glands are numerous about the nose and on the face; when the orifice becomes stopped up by dirt, the sebum accumulates within the duct, and the exposed part becomes oxidized, forming the so-called "black-heads." When pressed out they appear like little worms.

The sudoriferous, or *sweat* glands consist of a coiled duct leading up from the derma. They secrete the sweat. The entire number of these secreting glands is about 2,381,248; and assuming that each coil when unraveled measures about one-sixteenth of an inch, the entire length of the secreting tubes is about two and one-third miles.

The Sweat.

The total quantity excreted daily has been estimated at about two pounds, though the amount varies with the nature of the food and drink, exercise, season, etc.

Importance of Bathing.

The most important sanitary object of bathing is cleanliness. A secondary object of the bath is to stimulate the functions of the skin, and to produce a general feeling of exhilaration of the body.

Kinds of Baths.

Baths are of various temperatures. *Tepid*, *warm*, or *hot* baths are used principally as cleansing agents. They dilate the cutaneous blood-vessels and restore warmth to the body in certain cases of shock, or after exposure to cold. *Cold* baths are used not only for cleansing effects but principally for their stimulating effects upon the system. To a healthy person the cold bath is a delightful general stimulant, removing the sense of fatigue after physical exertion and causing a refreshing sensation in the body. Cold baths are used to reduce fevers, especially after heat-stroke. The most stimulating form of cold bathing is doubtless *sea-bathing*.

Times for Bathing.

The following series of rules have been issued by the English Royal Humane Society: "Avoid bathing within two hours after a meal. Avoid bathing when exhausted by fatigue or from any other cause. Avoid bathing when the body is cooling after perspiration. Avoid bathing altogether in the open air, if, after having been a short time in the water, there is a sense of chilliness, with numbness of the hands and feet; and bath when the body is warm, provided no time is lost in getting into the water. Avoid chilling the body by sitting or standing undressed on the banks or in boats,

after having been in the water. Avoid remaining too long in the water, but leave the water immediately if there is the slightest feeling of chilliness. The vigorous and strong may bathe early in the morning on an empty stomach. The young, and those who are weak, had better bathe two or three hours after a meal; the best time for such is from two to three hours after breakfast. Those who are subject to giddiness or faintness, or suffer from palpitation or other sense of discomfort at the heart, should not bathe without first consulting their medical adviser."

Clothing.

The primary importance of clothing is the protection of the body against the injurious influences of heat, cold, and moisture. Secondarily, the moral sense of civilized communities demands that the nude human body shall not be exposed in public.

The *materials* from which clothing is made are:

1. *Cotton.* This is cheap, does not shrink when wet and conducts heat readily, therefore valuable in summer.

2. *Linen.* This conducts heat better than cotton, is more durable and less harsh to the skin.

3. *Wool.* Absorbs water rapidly and is a poor conductor of heat, and, therefore, is valuable as a winter garment. *Flannels* are clothing of pure wool. "*Saxony wool*" is a mixture of wool and cotton.

4. *Silk* is often used for undergarments. It is light, soft and a bad conductor of heat.

5. The *skins* of animals are often used for outside clothing. Other materials used are rubber, leather, etc.

The *color* of clothing is of great importance. Ex-

periments made by Pettenkofer showed that if white cloth absorbed 100 heat units, dark yellow would absorb 140, dark green 168, light blue 198 and black 208 heat units. When protected from the sun's rays color is of little importance.

Adaption to Season of the Year.

Wool is a bad conductor of heat and is therefore adapted for winter wear.

Cotton and linen are good conductors of heat and therefore adapted for summer wear.

IV.—FOOD.

A food is that material which, when taken into the body and assimilated, sustains the processes of life, promotes growth, or prevents destruction of the organized constituents of the body.

Classification.

1. *Organic.*
    1. Nitrogenous substances.
        (*a*) *Proteids* — *e. g.*, albumin (egg), casein (milk), myosin (muscle), gluten (bread), etc.
        (*b*) *Gelatins.*
    2. Non-Nitrogenous substances.
        (*a*) *Amyloids* or *saccharine bodies*, chemically known as carbo-hydrates—*e. g.*, starches and sugars.
        (*b*) *Oils and fats.*
2. *Inorganic.*
    1. Foods which supply *mineral* and *saline matter.*
    2. Liquid food containing chiefly *water.*

Utility of a Mixed Diet.

Different experimenters have proven that a normal food must not consist of one aliment exclusively. As no one food contains the different essential principles in the necessary proportions, a mixed diet must be employed, and the nature of this diet must vary with the manner of living, with the climate and with the seasons.

Daily Amount of Food.

Dr. Dalton found that an adult requires food in about the following proportions :

	OUNCES.
Meat	16
Bread	19
Butter or Fat	3½
Water	52

or about two pounds and a half of solid food and about three pints of liquid daily.

A Consideration of a Few of the More Important Foods.

1. Foods of Animal Origin.—*Milk* is the one perfect food for man found in nature. It is frequently adulterated by the addition of water, which gives it a bluish tinge and lowers its specific gravity ; that of fresh milk should not be below 1030.

Butter is made from the cream by prolonged agitation in a churn. This is of special value as food on account of the large amount of easily digestible fat which it contains.

Oleo-margarine, when made from clean and sweet materials, and when the process of manufacturing is properly conducted, is a perfectly harmless article, and probably differs very little in nutritive value from butter itself.

Cheese is one of the most nutritious aliments obtainable, but it cannot be eaten in large quantities at a time, on account of its liability to cause disturbances of the digestive organs.

Meats. There are 47 varieties of the mammalian class, 105 of birds, 7 of amphibia, 110 of fish, and 58

of invertebrates that furnish food. Meat is the most important source of proteids in the food.

Eggs. Although eggs contain a large amount of the proteid and fatty alimentary principles, their value as food has been greatly overrated. It is probable that a hard boiled egg is quite as easily digested in the healthy stomach as a raw one, if care be taken to masticate it well and eat bread with it, so that it may be introduced into the stomach in a finely-divided state.

2. Foods of Vegetable Origin.—*Bread.* The flours of wheat, rye, barley, buckwheat, and Indian corn are almost exclusively used in bread-making. Flours made from the whole grain (bran-flour, Graham flour) is more nutritious than the white flour because the bran contains a larger proportion of the proteid principles.

Green vegetables comprise cabbage, turnips, parsnips, onions, beets, carrots, tomatoes, lettuce, green peas and beans, etc. They all contain a large percentage of water and a small percentage of proteid principles.

Fruits and nuts contain large quantities of sugars and fats.

3. Inorganic Foods.—*Water* is the most important. It comprises about three-fourths of the entire weight of the body. We require about three pints daily under ordinary circumstances.

Salt is an essential food and is contained in nearly all of the organs of the body. Soda, potash, magnesia, and especially the phosphate of lime, are important inorganic substances.

INTRODUCED WITH THE FOOD.	DISCHARGED WITH THE EXCRETIONS.
Albuminous matters.	Urea.
Fat.	Carbonic acid.
Carbohydrates.	Water.

This table represents the decomposition and structural changes of the organic substances proper; while the mineral ingredients of the food, as a rule, pass through the system unchanged.

The Object of Cooking.

1. To render food more digestible by softening it.
2. To develop flavors, which excite the flow of fluids of the mouth and stomach and so aid digestion.
3. To make it more pleasing to the eye and more agreeable to the taste.
4. To destroy all germs.

Water, Its Impurities.

The transparency and color of water are affected by the presence of suspended or dissolved mineral or organic matter. Large amounts of suspended mineral matter may give rise to derangements of the digestive organs. Typhoid fever and cholera are caused by impure drinking water.

Tea, Coffee and Chocolate, Their Effects, Beneficial and Injurious.

It is estimated that 500,000,000 people drink coffee, 100,000,000 tea, 50,000,000 chocolate. All these are active nervous stimulants. If taken to excess they are liable to produce serious functional disturbances of the nervous, digestive and circulatory systems. If taken in moderate quantity, these beverages enable the consumer to withstand cold, fatigue and hunger.

Alcohol

at first sharpens the appetite and quickens digestion, but its habitual use impairs both. Alcohol is a food in that it retards waste; it does not contribute nutritive material to the body; it only permits that which is stored up to be saved for other uses, by furnishing easily-oxidizable (combustible) material for carrying on the respiratory process and supplying animal heat. Hence, while alcohol has not the power to build up, it may obstruct the process of pulling down.

V.—DIGESTION.

The great design of food is to give nutriment or nourishment to the body ; to accomplish this the food must pass through certain preparatory changes, as follows :

1. *Digestion*, by which food is reduced to a soluble condition.

2. *Absorption*, by which, when ingested, it is imbibed into the blood.

3. *Circulation*, which carries the enriched blood to the various parts of the system.

4. *Assimilation*, by which each tissue derives from the blood the materials necessary for its support.

Digestion.

Digestion is the process by which the food is reduced to a form in which it can be absorbed from the intestinal canal, and taken up by the blood-vessels, and is divided into five stages, viz.:

1. *Prehension*, the act of conveying food into the mouth.

2. *Mastication*, the act of triturating the food.

3. *Deglutition*, the act of transferring food from the mouth into the stomach.

4. *Gastric* digestion.

5. *Intestinal* digestion.

Digestive Fluids.

1. *Saliva*, found in the mouth.
2. *Gastric*, found in the stomach.
3. *Bile*,
4. *Pancreatic*, } found in the intestines.
5. *Intestinal*,

Alimentary Canal.

The *Alimentary Canal* is a musculo-membranous tube, about thirty feet in length, lined throughout by

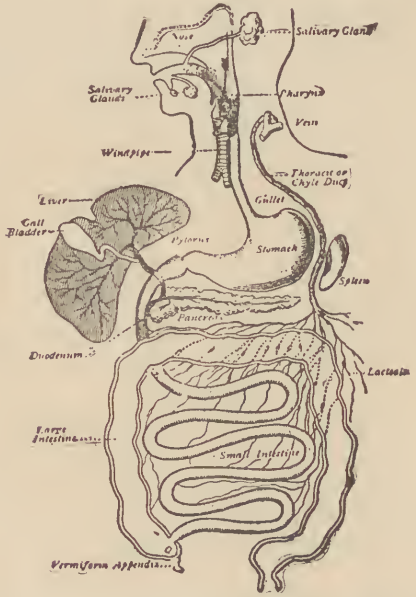


Fig. 15.—Scheme of the digestive tract (alimentary canal) and glands. (Landois.)

mucous membrane. It is composed of the following parts :

Mouth.	Small intestine.	Duodenum.
Pharynx.		Jejunum.
		Ileum.
Œsophagus.	Large intestine.	Cæcum.
Stomach.		Colon.
		Rectum.

Teeth.

Accessory Organs.

Salivary glands. { Parotid. Submaxillary. Sublingual.

Liver. Pancreas. Spleen.

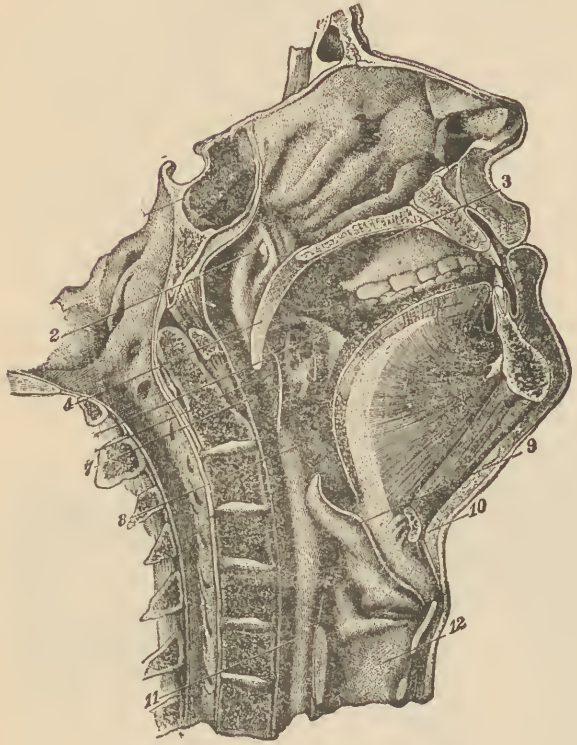


Fig. 16.—Cavities of the mouth and pharynx, etc. (Sappey.)

Section in the median line of the face and the superior portion of the neck, designed to show the mouth in its relation to the nasal fossæ, the pharynx, and the larynx; 2, internal orifice of the Eustachian tube; 3, palatine arch; 4, velum pendulum palati; 7, tonsil; 8, lingual portion of the cavity of the pharynx; 9, epiglottis; 10, section of the hyoid bone; 11, laryngeal portion of the cavity of the pharynx; 12, cavity of the larynx.

The *Mouth*, the commencement of the alimentary canal, is a nearly oval shaped cavity in which mastication of the food takes place.

The Teeth.

Their general character.—Each tooth consists of five portions:

1. The *crown* or *body*, projecting above the gum, which is covered by enamel.

2. The *root* or *fang*, the concealed portion.

3. The *neck*, the constricted portion between the two.

4. The *dentine* composes the substance of the tooth; in its center is the pulp cavity.

5. The *cement*, that portion of the dentine which is beneath the level of the gums.

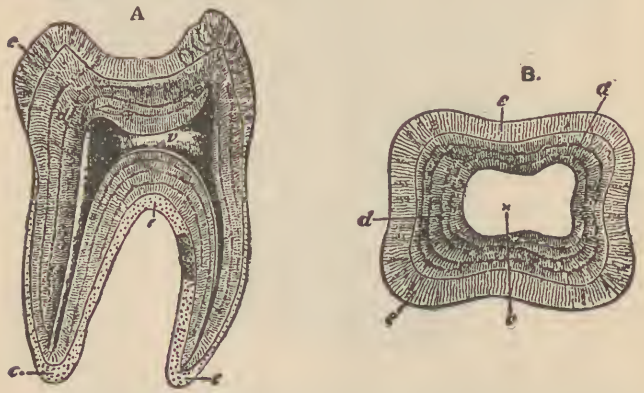


Fig. 17.—A, Longitudinal section of human molar tooth; *c*, cement; *d*, dentine; *e*, enamel; *v*, pulp cavity (Owen). B, transverse section; the letters indicate the same as in A.

The two sets.—1. The *temporary teeth*, are twenty in number—four incisors, two canines and four molars in

each jaw. 2. The *permanent teeth*, are thirty-two in number—four incisors, two canines, four biscuspids, and six molars in each jaw.

The accompanying formula shows, at a glance, the comparative arrangement and number of the temporary and permanent teeth :

Temporary Teeth.

MIDDLE LINE OF JAW.

Molars	Canines	Incisors	Incisors	Canines	Molars
2	1	2	2	1	2
2	1	2	2	1	2

Permanent Teeth.

MIDDLE LINE OF JAW.

True molars	Bicuspids or pre-molars	Canines	Incisors	Incisors	Canines	Bicuspids or pre-molars	True molars
3	2	1	2	2	1	2	3
3	2	1	2	2	1	2	3

The *incisor* teeth have cutting edges running from side to side.

The *canine* teeth have the long pointed tusks of the dog.

The *biscuspids* are smaller and shorter than the canine.

The *molars* are adapted for grinding and pounding the food.

So it is seen that in the human subject the teeth combine the characters of those of the carnivora and the herbivora.

The Cause of their Decay.

Particles of food which stick between the teeth, if allowed to remain, putrefy and give an offensive odor

to the breath. Here we have an acid decomposition; the acid tends to attack the enamel of the teeth and so causes decay. The enamel is Nature's defense for the teeth; when this is destroyed, decay follows. On this account, certain articles are to be guarded against; such as sharply acid substances that corrode this enamel, and hard substances that break or scratch it—as gritty tooth powders, metal tooth-picks, shells of hard nuts, etc.

Tartar is a substance deposited on the teeth, consisting of carbonate of lime mixed with bacteria and other organic matter.

Their Preservation.

A soft brush should be used twice daily *at least;* avoid gritty tooth powders; never attempt to crack nuts with the teeth; use wooden tooth-picks if necessary.

The Filling of the Teeth.

For decay to take place, it is necessary that there be moisture present; therefore, if beginning decay be noted, the prompt filling of the tooth will exclude moisture and the process will stop. On the slightest appearance of decay, consult a good dentist.

The Salivary Glands.

The Salivary Glands are three in number, viz.:

1. The *parotid*, which is the largest, situated upon the side of the face below and in front of the external ear. The duct of this gland is called Stenson's, and opens upon the inner side of the cheek by a small orifice opposite the second molar tooth of the upper jaw. It is this gland which becomes enlarged and so painful in the disease known as *mumps.*

2. The *submaxillary* is situated below the jaw. The duct of this gland (Wharton's) is about two inches in length and opens at the side of the *frænum linguæ*.

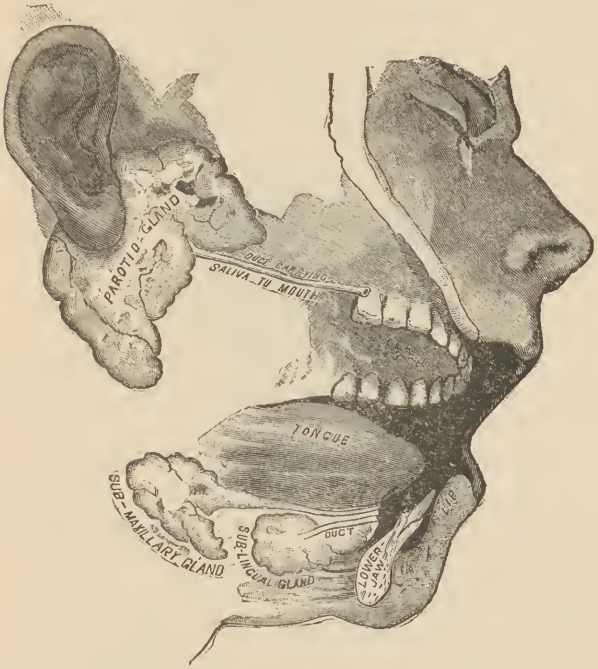


Fig. 18.—The salivary glands of the right side. (Tracy.)

3. The *sublingual* is situated in the floor of the mouth by the side of the *frænum linguæ*. Its ducts are from eighteen to twenty in number and are called the ducts of Rivini.

The office of these glands is to secrete the saliva.

Composition of the Saliva.

The saliva is a mixture of the secretions of the above named glands; it is a colorless, slightly opalescent, slightly viscid, alkaline fluid with a specific gravity of about 1005. Its ferment is called *ptyalin*.

The Action of the Saliva.

1. Its *physical* function is to soften and moisten the food and facilitate swallowing.

2. Its *chemical* function is to convert starch into grape sugar (due to the action of *ptyalin*).

The total amount of saliva secreted in twenty-four hours is about three pounds.

Deglutition.

This is divided into three stages, viz. :

1. The passage of the bolus from the mouth into the pharynx. This is a voluntary act, although it may be performed unconsciously.

2. From the pharynx into the œsophagus. This is an entirely reflex act.

3. From the œsophagus into the stomach. Entirely reflex.

The Œsophagus.

This is a tube from nine to ten inches in length. It is composed of three coats,—an outer, *muscular;* a middle, *submucous;* and an inner, *mucous.*

The Stomach and its General Anatomy.

The stomach is the most dilated part of the alimentary canal. It is about 13 inches long, 5 inches deep, and has a capacity of about 5 pints. It is placed immediately behind the anterior wall of the abdomen, beneath the diaphragm and liver.

The Openings of the Stomach.

1. *Œsophageal* or *cardiac*, communicating with the œsophagus.

2. *Pyloric*, communicating with the duodenum.

The Coats of the Stomach.

1. The external or *serous* coat, which presents a perfectly smooth surface, continually moistened, permitting free movements of the organ without friction.

Fig. 19.—Stomach, liver, small intestine, etc. (Sappey.)

1, inferior surface of the liver; 3, gall bladder; 5, diaphragm; 6, lower portion of the œsophagus; 7, stomach; 9, spleen; 11, duodenum; 12, 12, small intestine; 13, cæcum; 14, appendix vermiformis; 15, 15, transverse colon; 16, sigmoid flexure; 17, urinary bladder.

2. The *muscular* coat, which is divided into two principal layers—an external (*longitudinal*) and an internal (*circular*) layer; continuous with the circular fibres of the œsophagus is a third layer, limited to the cardiac end of the organ; this is called the *oblique* layer.

3. The *mucous* is the internal coat and is peculiar in that it is thrown into folds or *rugæ*. In the sub-

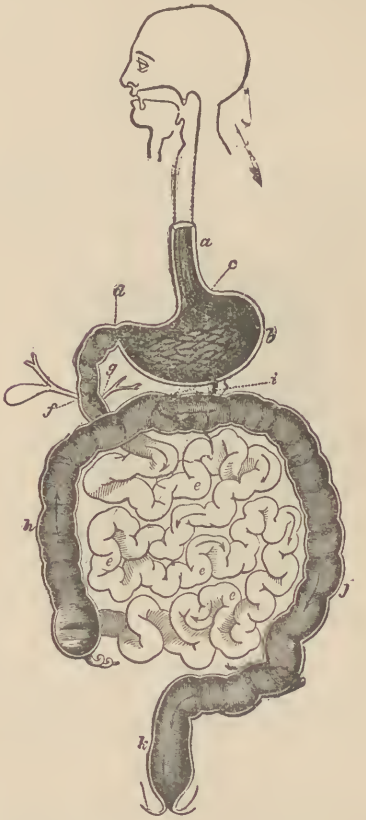


Fig. 20.—Human alimentray canal.—*a*, œsophagus; *b*, stomach; *c*, cardiac orifice; *d*, pylorus; *e*, small intestine; *f*, biliary duct; *g*, pancreatic duct; *h*, ascending colon; *i*, transverse colon; *j*, descending colon; *k*, rectum.

stance of the mucous membrane are embedded glands that secrete the gastric juice.

The Movements of the Stomach.

When food is introduced into the stomach the mus-

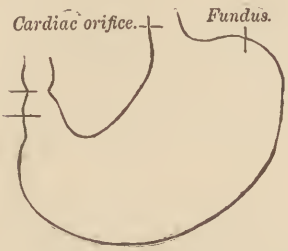


Fig. 21.—Diagrammatic outline of the stomach.

cular coats cause this organ to make peculiar motions

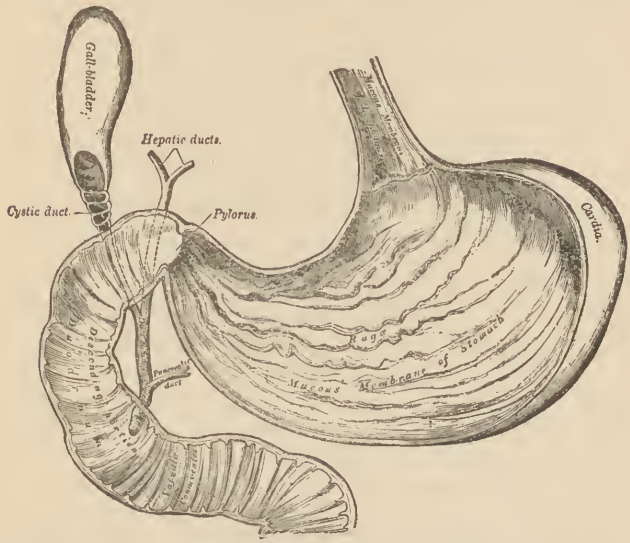


Fig. 22.—The mucous membrane of the stomach and duodenum, showing the *rugæ* of the former and the *valvulæ conniventes* of the latter.

and contractions (*peristalsis*) which continue so long

as any food remains in it. This serves to mingle the food more thoroughly with the gastric juice.

The Function of the Stomach.

1. To secrete a digestive fluid, the *gastric juice.*

2. To thoroughly incorporate the fluid with the food by means of its muscular movements.

3. To absorb such substances as are ready for absorption.

Dr. Beaumont and St. Martin.

In 1822 Alexis St. Martin, eighteen years of age, received a wound in the abdomen from the discharge of a shot-gun; in this situation was left an opening into the stomach, which was closed by a flap or valve of mucous membrane on the inside. Through this opening Dr. Beaumont made many observations, and established the following facts:

1. The active agent in digestion is an acid fluid, secreted by the walls of the stomach.

2. That this fluid is poured out only during digestion and under the stimulus of a food.

3. When the stomach is empty and inactive, no gastric juice is secreted, and an alkaline mucus covers its surface.

4. When food is introduced, the mucous membrane becomes reddened with the influx of a larger quantity of blood; the gastric glands begin to secrete actively and an acid fluid is poured out in minute drops.

The Gastric Juice.

This is a clear, straw-colored fluid, decidedly acid, with a specific gravity of 1002 to 1010. Two important constituents of this juice are the *hydrochloric acid* and the *pepsin.*

The *amount* secreted in twenty-four hours is from ten to twenty pints.

Functions of the Gastric Juice.

1. The *physical* function, by which the fibrous tissues of meats, the hard parts of grains and vegetables, are dissolved away and the food is reduced to a liquid condition.

2. The *chemical* function.

(*a*) The principal function of the gastric juice is to *convert proteids into peptones.* By this means it acquires the property of *diffusibility*, which permits the food to pass through animal membranes.

(*b*) Milk is curdled, due to *rennin.*

(*c*) The *proteid* envelop of fat is dissolved and the oil liberated.

(*d*) It has an *antiseptic* function in that it checks and prevents putrefaction.

Time Required for Stomach Digestion.

Varies greatly. Boiled pig's feet takes one hour; roast pork takes five and a quarter hours. The average time is about three hours.

Chyme is the product of gastric digestion.

The Small Intestine.

The *small intestine* is about twenty feet long and is divided into three portions, viz.:

1. *Duodenum*, which extends about eight or ten inches from the pyloric end of the stomach; into this empty small canals from the pancreas and liver.

2. *Jejunum*, which forms two-fifths.

3. *Ileum*, which forms three-fifths of the rest of the canal.

Structure of the Small Intestines.

It has three coats, viz.:

1. *Serous* coat, formed by the peritoneum.

2. *Muscular* coat, arranged in two layers, an outer, longitudinal, and an inner or circular coat.

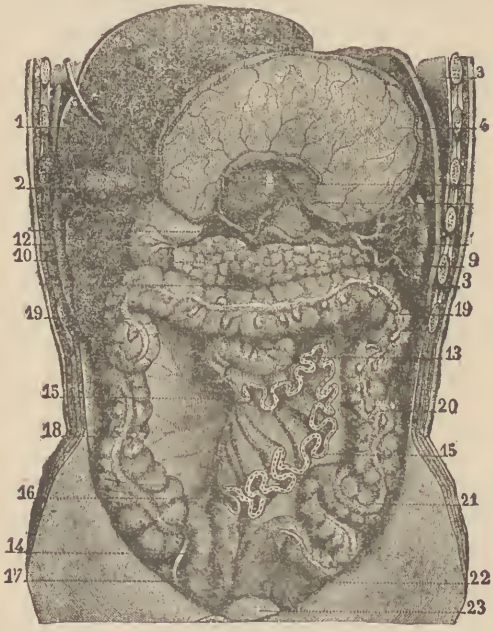


Fig. 23.—Stomach, pancreas, large intestine, etc. (Sappey.)

1, anterior surface of the liver; 2, gall-bladder; 3, 3, section of the diaphragm; 4, posterior surface of the stomach; 9, spleen; 10, pancreas; 12, duodenum; 13, upper extremity of the small intestine; 14, lower end of the ileum; 15, 15, mesentery; 16, cæcum; 17, appendix vermiformis; 18, ascending colon; 19, 19, transverse colon; 20, descending colon; 21, sigmoid flexure of the colon; 22, rectum; 23, urinary bladder.

3. *Mucous* coat, in which are the following structures to be described: the *valvulæ conniventes*, the *villi*, and the *glands*.

The *valvulæ conniventes* are formed of a folding inward of the mucous membrane; these crescentic, nearly circular folds are arranged transversely to the long axis of the gut. (See fig. 22.)

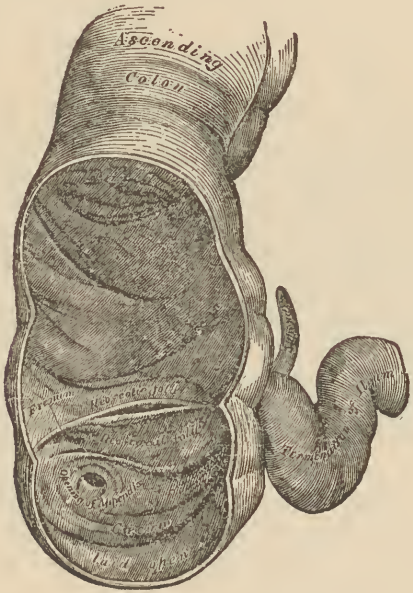


Fig. 24.—The cæcum and colon laid open to show the ileo-cæcal valve.

Their *function* are (1) to afford a largely increased surface for secretion and absorption; (2) to prevent the too rapid passage of the very liquid products of gastric digestion, immediately after their escape from the stomach; (3) to assist in the more perfect mingling of these products with the secretions.

The Large Intestine.

The large intestine is about four to six feet in length and is divided into three portions, viz.:

1. *Cæcum*, which communicates with the small intestine through an opening which is guarded by the *ileo-cæcal* valve; attached to this cæcum is the vermiform appendix, three to six inches in length.

2. *Colon*, which forms the principle part of the large intestine; it has an ascending, transverse and descending portion.

3. *Rectum*, which opens externally through the *anus*.

The *structure of the large intestines* is similar to that of the small intestines, except that the mucous coat is not thrown into folds forming valvulæ conniventes and it is quite destitute of villi.

The Liver.

The liver is the largest organ in the body, weighing from three to four pounds; it measures ten to twelve inches across, from six to seven inches in its antero-posterior diameter, and is about three inches thick. It is situated beneath the diaphragm, more appearing on the right than on the left side.

The Function of the Liver.

1. It secretes *bile*.
2. It forms *glycogen*.
3. It forms *urea*.

Bile is formed continuously in the liver, is stored up in the gall-bladder, from which it is discharged as required into the duodenum through a duct common to it and the pancreas. The passage of the acid chyme from the stomach acts as a stimulus, causing contrac-

tion of the gall-bladder and a consequent outpour of the bile.

The bile is a viscid fluid, of a yellowish or reddish-yellow or green color, a strongly bitter taste, and with very little odor ; it is alkaline in reaction, with a specific gravity of 1020.

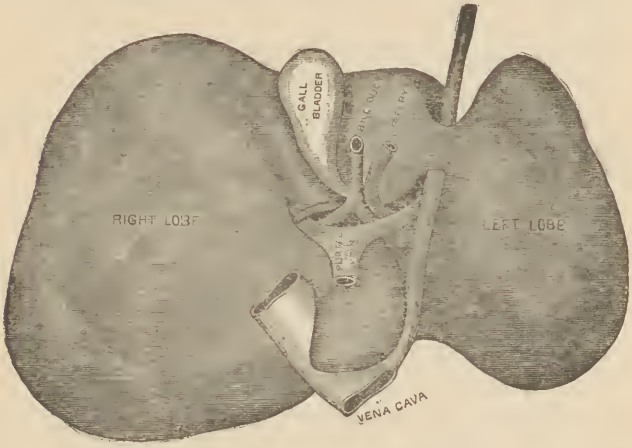


Fig. 25.—Under surface of the liver, showing the gall-bladder and a section of blood-vessels.

The Functions of the Bile.

1. Assists in *emulsifying the fats* of the food, so rendering them capable of passing into the lacteals.

2. It *moistens the mucous membrane*, and so facilitates absorption.

3. It has an *antiseptic* power, serving to prevent the decomposition of food in the intestines.

4. It stimulates the natural secretion of the intestinal glands.

The Pancreas.

This gland is situated across the posterior wall of the abdomen, is six or eight inches in length; its shape is somewhat like that of a pistol with the large end towards the right. (See fig. 23.) It secretes a fluid called the *pancreatic juice*, which is discharged into the duodenum, through a small duct common to it and to the liver.

The Properties of the Pancreatic Juice.

It is a colorless, transparent, slightly viscid, alkaline fluid.

The Functions of the Pancreatic Juice.

1. It converts *proteids into peptones* by the aid of the ferment *trypsin*.

2. *Starch is converted into glucose* by the aid of the ferment *amylopsin*.

3. It curdles milk.

4. It *emulsifies and saponifies fats*.

An *emulsion* is the minute division and suspension of globules of oil in a medium which is permanent.

5. It checks putrefaction.

The Function of the Intestinal Juice,

or the *succus entericus*, is said to be the converting of proteids into peptones, and to convert starch into sugar, but the evidence in favor of these actions is insufficient. It does possess the power of converting cane into grape sugar, and maltose into glucose.

The Spleen.

This organ embraces the cardiac end of the stomach. It is five inches long, four wide and an inch thick. (See fig. 23 and 15.)

The Function of the Spleen

is not definitely known; among the many theories may be mentioned:

1. It has been supposed to give rise to new red cells.

2. It has been supposed to be an organ for the destruction of red cells.

3. It has been suggested that uric acid is produced in the spleen.

Peristaltic or *vermicular* movements occur in the intestines, caused by the alternate contractions and dilatations of successive portions of the muscular coats. By means of these contractions the food and secretions are moved through the intestinal canal, are subjected to the influence of fresh portions of intestinal secretion, and the food is slowly exposed to the absorbent power of the villi and blood vessels.

Absorption.

There are two possible routes for the absorbed products to take; they may pass immediately into the *blood*, or they may enter the *lymphatic system*, the so-called "*lacteals*" of the alimentary canal.

Endosmose and Exosmose.

When two liquids of different gravities are separated by an animal membrane, two currents set in from opposite directions. The flow of the liquid towards that which increases in volume is *endosmose*, and the current in the opposite direction is *exosmose*. The general phenomenon may be called *diosmose*. For the production of endosmose it is necessary: (1) that the liquids be different but capable of mixing; (2) that the liquids be of different densities; (3) that the membrane must be permeable to at least one of the substances.

The Lymphatic Vessels.

These constitute a system of minute, delicate, transparent vessels, found in nearly all the organs and tissues of the body. How these vessels begin is not clearly understood, but they unite to form larger and larger vessels, until their contents are finally discharged into the veins and mingled with the blood. The fluid found in the lymphatics is called *lymph;* this is a yellowish, transparent fluid, derived from the blood, which nourishes the tissues and takes up and carries away the waste.

Fig. 26.—An intestinal villus.—*a*, Layer of cylindrical epithelium, with its external transparent striated portion; *b*, *b*, blood vessels entering and leaving the villus; *c*, lymphatic vessels occupying its central axis

The Villi.

The villi are confined exclusively to the small intestine. They are minute vascular processes which give

to the intestine its peculiar velvety, fleecy appearance. Sappey estimates that there are about 7,200 to the square inch and more than 10,000,000 throughout the whole small intestine.

Each villus consists of a projection of mucous membrane, while within this are found, reckoning from without inward, blood-vessels, muscular fibres, and a single *lymphatic* or *lacteal* vessel. The blood-vessels form a dense capillary network supported upon a basement membrane. The *lacteal vessel* in each villus is the form of commencement of the lymphatic system of vessels in the intestines. The villi are the active agents in the process of absorption.

Absorption by the Villi.

The oil is emulsified by digestion, forming in the intestine a white, milky fluid, termed the "chyle," which adheres to the surface of the villi; it soon passes onwards, penetrating deeper into the villi, until it is received at last by the capillary vessel in the interior, which is the commencement of the *lacteals*.

The lymphatic system of the intestinal canal originates in the substance of the villi; after leaving their base, they form a plexus from which branches pass from the intestine towards the posterior part of the abdomen, terminating in the *thoracic duct*.

The *thoracic duct* conveys the great mass of lymph and chyle into the blood. It is from fifteen to eighteen inches in length, lying in front of the bodies of the vertebræ. It empties its contents into the left subclavian vein.

Absorption by the Blood-Vessels.

The food is absorbed from the intestines by the veins, which unite with the veins from the stomach and spleen

to form the *portal vein*, which enters the liver, so that all the blood from the digestive apparatus first passes

Fig. 27.—Lacteals and lymphatics during digestion. The lacteals are shown in heavy white.

through the liver before it enters the general circulation.

Chyle Versus Lymph.

The fluid contained in the lymphatics—and the lacteals *during intervals of digestion*—is called *lymph*.

The fluid contained in that part of the lymphatic system belonging to the small intestines—the so-called "lacteals"—*during digestion*, is called *chyle*.

The presence of chyle in the lacteals is, therefore, not constant; during the process of digestion fatty substances are absorbed, which give to the lacteals its characteristic appearance; when the digestion and absorption come to an end, the milky fluid disappears from these vessels, and they resume their former transparent and colorless appearance.

The Waste of the Body.

As the digested food passes through the intestines, the nutritious matters are absorbed into the blood, and the residue enters the large intestine; the indigestible matters left constitute the *fæces*, which varies in amount from four to seven ounces in twenty-four hours.

Conditions Influencing Digestion.

Probably one-half the ill health of the entire world is due to improper eating. Derangements of the digestive organs are exceedingly frequent in school-children, which can generally be traced to this cause. The eating of cold lunches should be discouraged. Nuts, candies, fruit cake, and, above all, pickles, are fruitful sources of digestive derangements.

Severe mental or physical exertion retards digestion. Prolonged or deep sleep is injurious after meals. Strong emotions, such as excitement or depression, bad temper, anxiety, long fasting and bodily fatigue, check digestion.

Do not overeat ; if more food is introduced than the gastric juice can dissolve, fermentation occurs, resulting in the production of gas and irritating acids. Do not eat between meals ; the digestive organs need rest as well as other parts of the body.

Great exertion calls for a larger proportion of nitrogenous food ; great cold calls for a larger proportion of fatty food.

Aids to Digestion.

1. Proper selection of food, in regard to quality, quantity and temperature.
2. Best treatment of food as regards cooking, flavoring and serving.
3. Proper variety of food, with an occasional change of diet.
4. Moderate exercise, warmth and a genial state of the mind.
5. Abundance of sleep.
6. Pleasant social surroundings at table.
7. Thorough mastication.
8. Regularity in eating, and proper intervals between meals.

VI.—BLOOD.

The blood is a nutritious fluid containing all the elements necessary for the repair of the tissues; it also contains principles of waste absorbed from the tissues, which are conveyed to the various excretory organs and by them eliminated from the body.

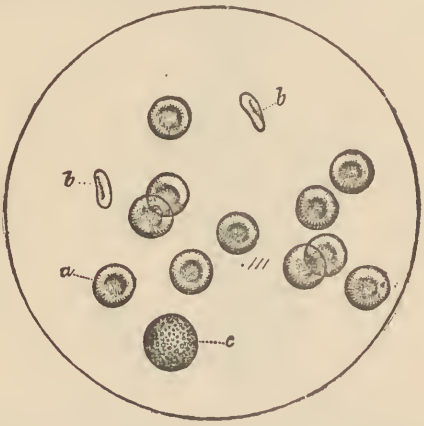


Fig. 28.—Human blood-globules.—*a*, Red globules, seen flatwise; *b*, red globules, seen edgewise; *c*, white globule.

General Properties of the Blood.

The *amount of blood* in an average human body is estimated to be about one-thirteenth the body weight.

The *color* of the blood is bright red or scarlet when it flows from the arteries; it is dark red or purple when it flows from the veins.

The *taste* is saline, due to the chloride of sodium present.

The *odor* is peculiar and quite characteristic of the animal from which it is drawn.

The *reaction* is alkaline, due to the alkaline sodium phosphate.

The *specific gravity* is about 1055.

The *temperature* of the blood is about 100° F., but it varies greatly in different parts of the body.

It is *viscid* and has a somewhat *clammy* feel.

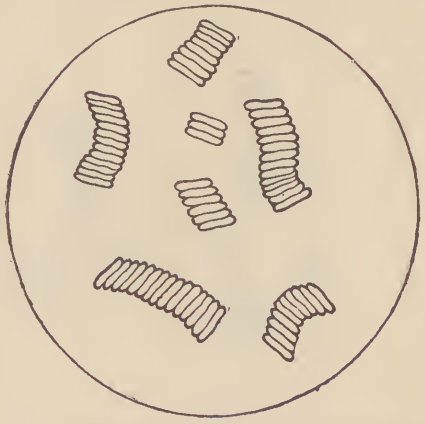


Fig. 29.—Red globules of the blood, adhering together like rolls of coin.

Function of the Blood.

1. It carries to the tissues food-stuffs after they have been properly prepared by the digestive organs.

2. It transports to the tissues oxygen absorbed from the air in the lungs.

3. It carries off from the tissues various waste products.

4. It aids in equalizing the temperature of the body.
5. It keeps the parts moist.

The Composition of the Blood.

The blood consists of a nearly colorless, transparent, alkaline fluid, termed the *plasma*, holding in suspension a large number of distinct cells, or corpuscles, the *blood-globules*. The globules of the blood are of two kinds, the red and the white.

Fig. 30.—A large capillary, showing emigration of leucocytes. *a*, Cells in the act of traversing the capillary wall; *b*, some already escaped. (Frey.)

The *red blood-corpuscle* is a circular biconcave disc, about 1-3500 of an inch in diameter. When examined under the microscope it will be seen that they adhere to one another by their flat surfaces arranging themselves like rolls of coin (see fig. 29). The red color is due to the *hæmoglobin*.

The *function* of the red corpuscle is to carry oxygen, which combines with the hæmoglobin, forming oxy-

hæmoglobin ; this combination is largely influenced by the *iron* present.

The *white blood-corpuscles* or *leucocytes* are spheroidal bodies, somewhat larger than the red corpuscle, measuring about 1-2500 of an inch in diameter. They have two or three nuclei. They have the property of undergoing "amœboid" changes. By means of these amœboid changes they have the property of wandering or emigrating from the blood-vessels by penetrating their coats (see fig. 30, also fig. 66.) The white cell is far less numerous than the red cell, the proportion being about 1 white to 400 red.

The *function* of the white corpuscles: (1) they protect the body from pathogenic bacteria; (2) they take part in the process of blood-coagulation.

Fig. 31.—Diagram to illustrate the process of coagulation.

1. Fresh. (Corpuscles and plasma.) 2. Coagulating. (Birth of fibrin.) 3. Coagulated. (Corpuscles plus fibrin.)

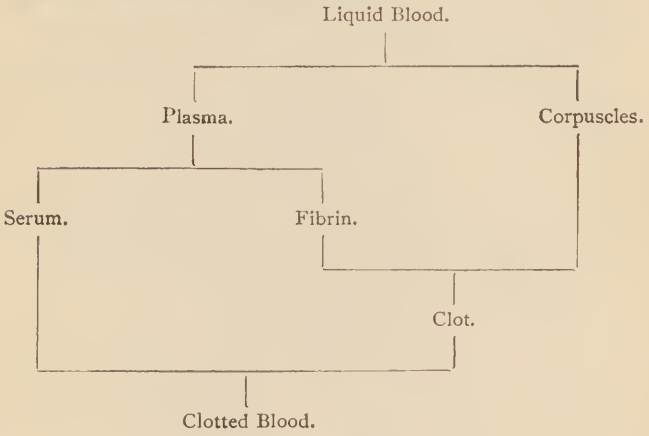
Plasma minus fibrinogen equals serum. Corpuscles plus fibrin equals clot.

Coagulation of the Blood.

One of the most striking properties of the blood is its power of clotting or coagulating after it escapes from the blood-vessels. The clot consists of *fibrin*, which has entangled in its meshes blood-corpuscles. The fluid left after clotting is called *serum*. If we whip blood with twigs while it is clotting fibrin will adhere to them.

The serum differs from liquor sanguinis or plasma in not containing fibrinogen.

The relation of these various constituents of the blood to each other will be easily understood by a reference to the subjoined plan :



VII.—CIRCULATION.

The circulatory apparatus consists of the following parts:

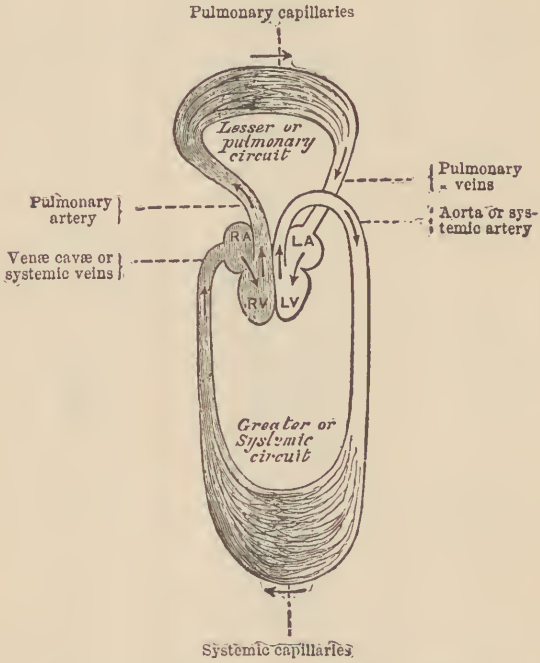


Fig. 32.—Diagram of the circulation. (*Waller.*)

1. The *heart*, a hollow, muscular organ, which propels the blood.

2. The *arteries*, which convey the blood from the heart to different parts of the body.

3. The *capillaries*, which bring the blood into intimate contact with their component parts.

4. The *veins*, which collect the blood from the capillaries and return it to the heart.

The General Anatomy of the Heart.

The heart is situated in the chest between the lungs, behind the sternum, placed obliquely from right to left. It it pyramidal in shape, with its apex

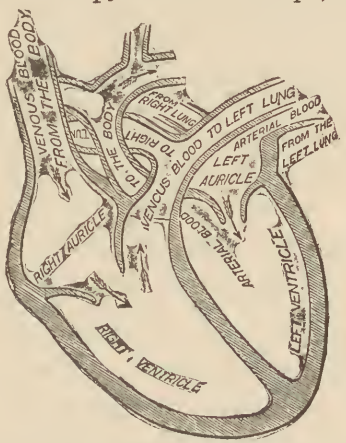


Fig. 33.—Diagram illustrating the cavities of the heart and the course of the blood through them. (Tracy.)

pointing downward, outward and to the left. It is covered by a serous membrane called the *pericardium*. The weight of the heart is from eight to twelve ounces.

The Chambers of the Heart.

The interior of this organ is divided by a longitudinal partition into two chief chambers or cavities—right and left. Each of these cavities is divided by a transverse partition into two parts, called the *auricle* and *ventricle*, which freely communicate with each other. Therefore, the heart is divided into four

cavities, the right auricle and the right ventricle; and the left auricle and the left ventricle. The right side of the heart does not communicate with the left side, but each auricle communicates freely with each ventricle.

The Double Circulation.

1. The *systemic* circulation, which includes the movements of the blood from the left side of the heart through the aorta and its branches, through the capillaries and veins to the right side.

2. The *pulmonary* circulation, which includes the course of the blood from the right side through the pulmonary artery, through the capillaries of the lungs and pulmonic veins to the left side of the heart.

The Valves of the Heart.

The openings between the auricle and ventricle on each side of the heart—the auriculo-ventricular openings—as well as the aortic and pulmonic orifices, are furnished with *valves* which force the blood to flow in one direction; valves prevent regurgitation.

The Course of the Blood.

From the veins—the *venæ cavæ*—the blood passes into the right auricle, from the right auricle into the right ventricle, through the right auriculo-ventricular orifice; on the contraction of the right ventricle, the auriculo-ventricular valves shut back, preventing the return of the blood into the auricle; thus it is driven into the *pulmonary* artery to the lungs. Returning from the lungs it enters the left auricle, thence passes through the left auriculo-ventricular orifice into the left ventricle, from which it is finally driven into the *aorta* and distributed throughout the body.

The Action of the Heart.

The heart's action in propelling the blood consists in the successive alternate contraction (*systole*) and relaxation (*diastole*) of the muscular walls of the two auricles and two ventricles.

The Sounds of the Heart.

When the ear is placed over the region of the heart, two sounds may be heard at every beat of the heart, which follow in quick succession ; these sounds may be expressed by the words *lubb—dup*. The vibration of the valves enter largely into the cause of these sounds.

The frequency of the heart's action, in a healthy adult, is about 72 to the minute. There is about 1 respiration to every 3 or 4 beats.

The Arteries.

The arteries are branching tubes conveying blood to all parts of the body.

The Structure of an Artery.

An artery is composed of three coats, viz. :

1. *External*, strong and tough.
2. *Middle*, unstriped muscular fibres and elastic tissue.
3. *Internal*, a thin elastic membrane.

Arteries possess elasticity and contractility.

The Pulse.

When the heart contracts, from four to six ounces of blood are injected with great force into arteries already full of blood ; the arteries are elastic and so distend to accommodate this mass of blood ; when the heart relaxes this active distending force is suspended,

and the elastic arterial walls, reacting upon their contents, would drive the blood back into the heart were it not for the closure of the valves. The blood is then urged onward. When the arteries have returned to their previous dimensions, again are they distended by another contraction of the heart. In this way a succession of expansions are produced, felt in the arteries throughout the body, which is known under the name of arterial *pulse*.

The Veins.

The veins are the vessels which return the blood to the heart.

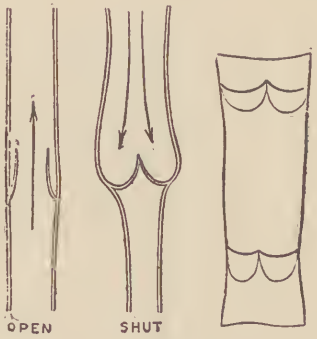


Fig. 34.—Venous valves. To right of figure, a vein laid open to expose the pocket-shaped valves.

The Structure of a Vein.

Veins possess three coats, viz. :

1. *External*, stronger and tougher than that of the artery.

2. *Middle*, consisting of unstriped muscular fibres, mingled with some elastic fibres ; this coat is thinner than that of the artery.

3. *Internal*, similar to that of the artery, except that veins have *valves;* arteries have none. These *valves* are arranged in pairs, always look towards the heart, and when closed prevent the return of blood in the veins. (See fig. 34).

The Capillaries.

These are minute vessels, of microscopic size, which distribute blood to the inmost recesses of the tissues, communicating with the arteries on the one hand and with the veins on the other.

Forces that Cause the Blood to Circulate.

1. In the arteries—
   - (*a*) The systole of the heart.
   - (*b*) The elasticity of the arteries.
2. In the capillaries—
   The *vis a tergo* or arterial pressure.
3. In the veins—
   - (*a*) The *vis a tergo—i.e.*, the action of the left ventricle acting through the capillaries.
   - (*b*) Muscular action, by which many of the veins are at times compressed, thus forcing the blood toward the heart, regurgitation being prevented by the action of the valves.
   - (*c*) A suction force exerted by the action of the thorax in respiration.
   - (*d*) A possible influence from the contraction of the coats of the vessels themselves.
   - (*e*) The force of gravity.

The Rapidity of the Circulation of the Blood.

In the arteries.—The speed is greatest in the aorta, and diminishes as it nears the capillaries. It is about 12 inches per second.

In the capillaries.—Very difficult to estimate, but it is supposed to be about 1 inch in 20 seconds.

In the veins.—Impossible to fix upon any definite rate, but it will average about 8 inches per second.

Course of the Blood Through the Heart, Arteries, Capillaries and Veins.

Tracing the blood as it passes from one part of the circulatory apparatus, say the right auricle, back to the same point, we note that it passes :

1. From right auricle to right ventricle ; it pours through the opening between the auricle and ventricle, which is guarded by the auriculo-ventricular valve.

2. From right ventricle to the lungs through the pulmonary artery.

3. Through the capillaries of the lungs ; here the venous blood brought to the lungs is changed to arterial blood—*i.e.*, it becomes oxygenated.

4. From the lungs to the left auricle through the pulmonary veins. This represents the *pulmonic circulation*.

5. From the left auricle to the left ventricle ; it pours through the opening between the auricle and ventricle, which is guarded by the auriculo-ventricular valve.

6. From left ventricle it passes out into the aorta to be distributed everywhere.

7. Through the capillaries of the system ; here the arterial blood is changed to venous blood—*i.e.*, it loses the oxygen.

8. From the capillaries, through the veins, back to the right auricle again where we started from. This represents the *systemic circulation.*

Names of the Principal Arteries.

The *aorta* is a very large artery, which leaves the left ventricle, forms an arch in the chest, passes down through the diaphragm, hugs the bodies of the vertebræ and in the lower part of the abdomen divides into two sets of vessels which go to supply the two lower extremities.

The *femoral* artery is situated in the thigh, occupying its central part anteriorly.

The *subclavian* arteries run upwards and outwards from the arch of the aorta behind the clavicle or collar bone.

The *axillary* artery is the continuation of the subclavian, occupying the axillary space.

The *brachial* artery is a continuation of the axillary down the arm. It lies along the inner side of the biceps.

The *radial* and *ulnar* arteries are situated in the forearm.

The *carotid* arteries run upward in the neck ; the *internal carotid* supplies the interior of the cranium ; the *external carotid* supplies the parts about the neck and face.

The *vertebral* arteries arise about the middle of the collar bone and pass up into the skull to assist in supplying the brain.

Names of the Principal Veins.

The veins are called, as a rule, by the same name as the artery which it accompanies. A few exceptions are :

The *jugular* veins, companions of the carotids, situated in the neck.

The *vena cava inferior* collects the blood from the lower part of the body; it passes up along the spine, emptying its blood into the right ventricle.

The *vena cava superior* collects the blood from the head and upper extremities and empties it into the right auricle; it is situated behind the sternum.

The *portal* vein receives the blood from the digestive organs, passes to the liver, divides and subdivides into minute branches and ultimately into a capillary system, the blood of which is gathered up by a vein, the *hepatic*, which empties into the vena cava inferior. Therefore, the blood coming from the digestive organs must pass through the liver before it enters the general circulation.

The Sinuses of the Dura Mater.

These are venous channels, analogous to the veins, their outer coat being formed by the dura mater, their inner, by a continuation of the lining membrane of the veins.

Do Arteries Always Carry Arterial Blood?

An artery is a vessel that carries blood *away from* the heart; therefore, the pulmonary artery carries venous blood.

Do Veins Always Carry Venous Blood?

A vein is a vessel that carries blood *towards* the heart; therefore, the pulmonary vein carries arterial blood.

Chemical Changes that the Blood Undergoes During Circulation.

The principal chemical change is that occurring in the red corpuscle in its passage through the lungs. The oxygen which is absorbed from the air in the

lungs unites with the hæmoglobin of the red corpuscle, forming *oxy-hæmoglobin*.

The carbonic acid which is taken up by the blood in its passage through the tissues is principally contained in the plasma, and not in the blood corpuscles.

Oxy-hæmoglobin gives to blood its arterial character.

Blood charged with carbonic acid gives it its venous character.

The arterial blood contains on an average about 7 per cent. more oxygen and 6 per cent. less carbonic acid gas than venous blood.

Difference Between Arterial and Venous Blood.

ARTERIAL BLOOD.	VENOUS BLOOD.
1. Bright red in color.	1. Deep purple color.
2. Contains more oxygen.	2. Contains less.
3. Contains less carbonic acid.	3. Contains more.
4. It is more coagulable.	4. Less coagulable.

VIII.—RESPIRATION.

Respiration is the process by which the tissues receive and appropriate oxygen.

The respiratory apparatus consists of the nasal passages, larynx, trachea and lungs.

The Nasal Passages.

The nasal cavities constitute the true beginning of the air-passages, and they extend backward to the upper opening of the throat, the larynx. The external

Fig. 35.—Ciliated epithelium from the human trachea. (Cadiat.)

opening of the nose is guarded by *short, stiff hairs*, which grow just inside the nostrils; their function is to purify the air in its passage through, by catching and retaining particles of dust.

The Mucous Membrane of the Respiratory Tract.

This membrane is peculiar in that its superficial epithelial cells are of the *ciliated* variety. These ciliated cells show a rapid whip-like movement of their *cilia* (see fig. 35). In the respiratory tract, the movement of these cilia is always from within outwards.

The Functions of the Nasal Passages

are three in number, viz. :

1. They restrain the passage of solid particles into the lungs.

2. They warm the air inspired.

3. They give up moisture sufficient nearly to saturate the air.

The *sense of smell* is considered under "Special Senses."

The larynx will be considered under the heading "Voice and Speech."

The Trachea.

This is a tube which extends from the larynx to the lungs. It measures about four and a half inches in length and three quarters of an inch in breadth. It consists of a membrane within the layers of which are enclosed a series of cartilaginous rings from sixteen to eighteen in number. These rings extend only about two-thirds of its circumference and are deficient behind. The trachea is situated in the neck in front of the œsophagus ; if these rings were complete they would interfere with deglutition. The trachea divides into two smaller tubes called *bronchi*, which enter the lungs. At the upper extremity of the trachea is the *larynx*.

The General Anatomy of the Lungs.

The lungs are the essential organs of respiration ; they are two in number, situated in the chest with the heart between them, covered over by a serous membrane called the *pleura ;* this pleura has two layers, one of which adheres closely to the lung's surface, providing it with a smooth and slippery covering, while the other

adheres to the inner surface of the chest-wall. Each lung is divided into *lobes*, three on the right, and two

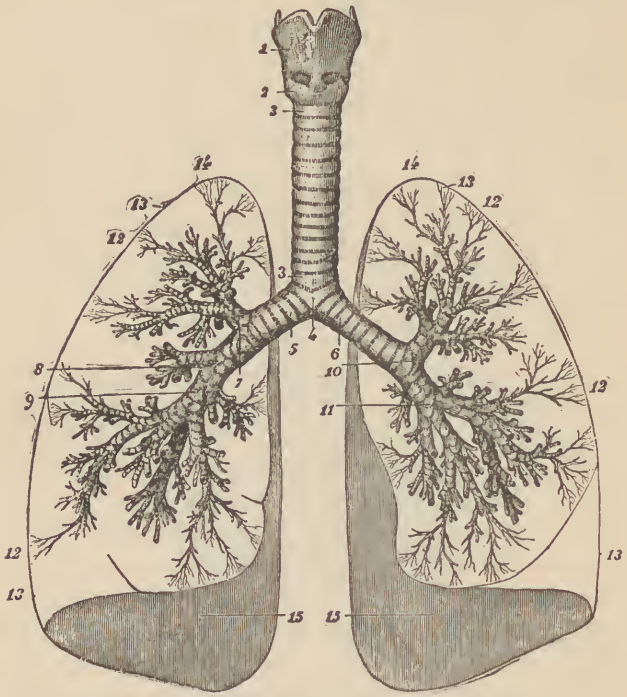


Fig. 36.—Trachea and bronchial tubes. (Sappey.)

1, 2, Larynx; 3, 3, trachea; 4, bifurcation of the trachea; 5, right bronchus; 6, left bronchus; 7, bronchial division to the upper lobe of the right lung; 8, division to the middle lobe; 9, division to the lower lobe; 10, division to the upper lobe of the left lung; 11, division to the lower lobe; 12, 12, 12, 12, ultimate ramifications of the bronchi; 13, 13, 13, 13, lungs, represented in contour; 14, 14, summit of the lungs; 15, 15, base of the lungs.

on the left side. Each of these lobes again is divided into a large number of smaller parts, called *pulmonary*

lobules. Each pulmonary lobule may be considered to be a lung in miniature. This pulmonary lobule measures about 1-12 of an inch in diameter, constituting a small cavity, into which dip little partitions, which create hollow spaces around the side of the lobule, called *pulmonary vesicles*. These vesicles are about 1-75 of an inch in diameter and are the smallest

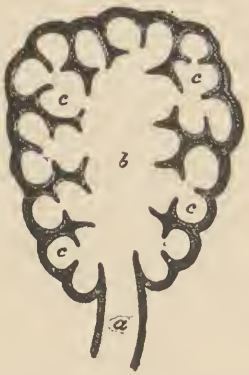


Fig. 37.—Simple pulmonary lobule.—*a*, Bronchial tube; *b*, cavity of lobule; *c*, *c*, *c*, *c*, pulmonary vessicles.

division of the lungs. It is in these pulmonary vesicles that the interchange between the air, on the one hand, and the blood, on the other, takes place.

The Respiratory Mechanism.

Respiration consists of an alternate expansion and contraction of the thorax, by means of which air is drawn into or expelled from the lungs. These acts are called *Inspiration* and *Expiration*.

The thorax is capable of enlargement in all directions. It is cone-shaped, the top of the cone being

closed in by the structures of the neck; the sides, by the vertebral column, ribs, costal cartilages, sternum, muscular and other tissues; and the bottom, by the arched diaphragm. The thorax is an air-tight box; therefore, enlargement in any one direction must cause a diminished pressure within the lungs, while a shrinkage would bring about an opposite condition of increased pressure. The trachea is the only means of communication between the lungs and atmosphere; therefore, any alterations in pressure must cause either an inflow or an outflow of air. The inflow is called *inspiration* and the outflow *expiration*.

Inspiration.

Inspiration, with its accompanying enlargement of the thorax and inflation of the lungs, is accomplished by the action of certain muscles, the chief one of which is the *diaphragm*.

Expiration.

Expiration, with its shrinkage of the thorax and the lungs, is accomplished mainly or solely by the passive return of the displaced parts; normal expiration is therefore a passive act.

Breathing, or *tidal air*, is the term used to express the quantity of air which is habitually changed in each act of breathing; it averages about 30 cubic inches.

The respiratory capacity is the term used to denote the quantity of air which a person can expel from his lungs after a forced inspiration; it averages about 250 cubic inches.

The number of respirations in a healthy adult ranges from 14 to 18 per minute.

Composition of Atmospheric Air.

The average composition of pure atmospheric air per cent. by volume is as follows :

Oxygen	20.96
Nitrogen	79.00
Carbonic acid	.04
Ozone, mineral salts, and organic matter	traces
Ammonia and watery vapor	variable

Composition of the Air Which has Been Breathed.

1. An increase of temperature. Whatever may be the temperature of the air when inhaled, it is nearly that of the blood when exhaled.
2. An increase in the quantity of carbonic acid.
3. A diminution in the quantity of oxygen. Nearly five per cent. is taken from the inspired air.
4. A diminution of volume.
5. An increase in the amount of watery vapor. The amount of watery vapor exhaled from the lungs in twenty-four hours is about ten ounces.
6. The addition of a minute amount of organic matter and ammonia.

Changes in the Blood, the Result of Respiration.

What the air has lost the blood must gain; therefore,—

1. It gains oxygen.
2. It loses carbon dioxid.
3. It becomes slightly cooler.
4. It coagulates sooner and more firmly.
5. It changes color.

Air—Its Impurities.

1. Air vitiated by respiration.
2. Air rendered impure by combustion.

3. Air rendered impure by sewage and cesspool effluvia and other animal matter.

4. The air of marshes.

The Relation of Plant Respiration to Animal Respiration.

Chlorophyll is the coloring matter which gives to plants their green hue and which has the property of decomposing carbon dioxid gas and of fixing the carbon in the structures in the form of some new compound; the oxygen is liberated. Animals, in turn, take up the oxygen, returning the carbon dioxid gas. In order that chlorophyll may act a part in this interchange of gases sunlight is necessary.

The Principles of Ventilation.

During ordinary respiration an adult human being adds 14 cubic feet of carbon dioxid to, and substracts 16 cubic feet from, the atmosphere in twenty-four hours. Hence, if the individual were confined in an apartment where the enclosed air could not be intermingled by diffusion with the atmosphere without, the proportion of carbon dioxid would soon become so great that the processes of life could not be sustained. .07 per cent. (7 parts in 10,000) of carbon dioxid in the air indicates the greatest amount of impurity consistent with the preservation of health. Not less than 2,000 cubic feet per head should be allowed in sleeping apartments; this allowance should be maintained by a perfect system of ventilation.

Speedily fatal results follow from overcrowding and poor ventilation. Of the 146 prisoners confined in the "Black Hole of Calcutta," 123 died in one night. Of the 150 passengers that were shut up in the cabin

of the Irish steamer *Londonderry*, with hatches battened down during a stormy night in 1848, 70 died before morning.

A Few Rules for a System of Natural Ventilation.

1. The air must be taken from a pure source.

2. The apertures of entrance and exit for the air should be placed far enough apart to permit thorough diffusion of the fresh air.

3. Have the incoming air deflected upward by an inclined plane; this prevents cold air from descending over the shoulders of the occupants.

4. The inlets should be numerous and small.

5. If the air cannot be warmed, the inlets should be near the ceiling.

6. Outlets should be placed at the highest point of the room and should be protected from the weather.

7. A small space between the horizontal bars of the upper and lower window-sash will admit sufficient air in small rooms.

8. Open doors and windows often to permit a thorough flushing of the interior with fresh air.

Animal Heat.

It is characteristic of living creatures that they maintain a standard temperature. The temperature of a being is about the same in summer or in winter. Under the tongue of man this temperature represents about 100 degrees F. The temperature varies in different parts of the body, depending upon the degree of oxidation that takes place.

Circumstances Causing Variation in Temperature.

1. *Age.* Temperature of an infant is slightly higher than that of an adult.

2. *Sex.* That of a female is higher than that of a male.

3. *Period of day.* It is highest late in the afternoon.

4. *Exercise.* Active exercise raises temperature.

5. *Season.* Little higher during the summer.

6. *Food and drink.* A hearty meal increases, and starvation lessens temperature.

7. *Disease.* Certain diseases raise the temperature very markedly.

8. *Baths*, etc.

The Production of Heat.

Every contraction of a muscle, every act of secretion, every exhibition of nerve force, even a thought, is accompanied by oxidation, and, therefore, heat. Oxidation cannot occur without the production of heat.

Heat Producing Tissues.

1. *The muscles.* Every manifestation of muscular energy is always accompanied by the evolution of heat and the production of carbon dioxid.

2. *The secreting glands*, especially the liver, come next to the muscles as heat producers.

3. *The brain* and all other living tissues contribute their quota.

Variations in the Loss of Heat

are regulated by :

1. Radiation and conduction from its surface.

2. Evaporation, thus rendering heat latent.

Probably 90 per cent. of the loss of heat from the body takes place by radiation, conduction and evaporation from the skin.

3. Heat given off during respiration. The exhaled air is cooler than the inhaled.

4. Food and drink that are introduced into the body cold abstract heat.

5. All excretions.

When Exposed to Great Cold

there are two principal sources of heat supply, viz.:

1. Muscular activity; this is one of the requisite conditions of resistance to cold.

2. An increased supply of food. In ill fed animals the resistance to cold is far less than in well fed animals. A larger quantity of food is taken during the winter than in the summer. In the arctic regions there is a greater consumption of food.

IX.—NERVOUS SYSTEM.

The nervous matter is divided into two great systems, viz.:

1. *The cerebro-spinal* system, composed of the *brain* and *spinal cord*, with the *nerves* directly connected with these centers. This system is especially connected with the functions of relation, or of animal life, supplying *voluntary muscular fibres.*

2. *The sympathetic* or *organic* system. This system is especially related to the functions of nutrition, supplying *involuntary muscular fibres.*

General Structure of the Nervous System.

Under the microscope the nervous tissue is found to consist of two main elements, namely, nerve *fibres* and nerve *cells.*

Varieties of Nerve Fibres.

1. *Medullated* or *white* fibres, which appear in the *cerebro-spinal nerves.*

2. *Non-medullated* or *gray* fibres, which constitute the principal part of the trunk and branches of the *sympathetic nerves.*

Medullated nerve fibres are made up of the following parts:

1. The central *axis cylinder*, which is the *essential* or *conducting* part of the fibre.

2. The *white substance of Schwann*, or *medullary sheath*, which gives to the nerve-fibre its white, shining aspect. The function of this sheath is generally con-

sidered to be that of an isolating substance, like the gutta-percha envelope of a submarine telegraph wire.

3. The *neurolemma*, which is a transparent, tubular sheath, whose function is that of a protecting envelope.

Non-medullated nerve fibres consist of the *axis cylinder* destitute of any medullary layer.

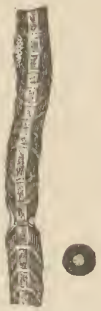


Fig. 38.—Transverse and longitudinal sections of a medullated nerve-fibre.

Varieties of Nerve Cells.

Depending upon the number of projections, or *poles*, that each cell possesses, they are termed uni-polar, bi-polar, tri-polar, multi-polar, etc. It is important to bear in mind the fact that these *poles* are continued into a nerve-fibre constituting its axis cylinder.

Nerve centers are made up of *nerve cells;* they are *gray* in color; their function is to receive, originate and reflect impressions. Every collection of *gray matter* is called a "nervous center."

Nerves are made up of *nerve fibres;* their function is to conduct impressions.

The Nervous System

consists of the following parts:

1. Large masses of nervous matter situated within the cranial cavity and spinal column, and constituting the *brain* and *spinal cord*.

2. Smaller masses of nervous matter, situated in the head, neck, thoracic and abdominal cavities, etc., constituting what are known as *sympathetic ganglia*.

3. Cords of nerve-fibres which connect the central nervous system with the periphery and with the so-called sympathetic ganglia.

4. Peripheral organs in connection with the beginnings or endings of the nerves at the periphery of the body.

Function of Nerve-Fibres.

The office of a nerve-fibre is to conduct impressions. If a nerve be stimulated an impression is conveyed either toward the center (sensory nerve) or towards the periphery (motor nerve), never both ways through the same nerve-fibre.

Impressions made upon a *centripetal* nerve may cause:

1. Pain.
2. Special sensation
3. Reflex action.

Impressions made upon a *centrifugal* nerve may cause:

1. Contraction of muscle (motor nerve).
2. Influences nutrition (trophic nerve).
3. Influences secretion (secretory nerve).

As a general rule, *centripetal* and *centrifugal* nerve fibres are associated together in the same nervous

bundle, and become separated from each other only at their final distribution in the skin and mucous membrane on the one hand, and in the muscles on the other.

Stimuli of Nerves.

All nerves possess the property of being called into action upon the receipt of a stimulus, in virtue of the possession of an inherent property denominated *irritability* or *excitability*. The irritability of a motor nerve is shown by the contraction of a muscle. The irritability of a sensory nerve is demonstrated by the development of a conscious sensation. Nerve stimuli may be divided into *general* and *special*.

General Stimuli.

1. Mechanical, as from a blow, pressure, etc.
2. Thermal; heating a nerve first increases and then diminishes its excitability.
3. Chemical; as from the application of an acid.
4. Electrical.
5. The normal physiological stimulus:—
   (*a*) Centrifugal, from the center toward the periphery.
   (*b*) Centripetal, from the periphery toward the center.

Special Stimuli.

1. Light acting upon the end organs of the optic nerve.
2. Sound, or undulations acting upon the end organs of the auditory nerve.
3. Heat, acting upon the end organs in the skin.
4. Chemical agencies acting upon the end organs of the olfactory and gustatory nerves.

The cerebro-spinal system consists of the *spinal cord* and its *nerves*, and the *brain*, made up of cerebrum, crura cerebri, and the ganglia in connection with them.

Membranes of the Brain and Spinal Cord.

1. The *dura mater*, or external covering, which is a strong fibrous membrane, forming a loose sheath around the cord. The chief peculiarities of the dura mater of the cord, as compared with that investing the brain, are the following:

(*a*) The dura mater of the cord is not adherent to the bones of the spinal canal.

(*b*) It does not send partitions into the fissures of the cord, as in the brain.

(*c*) Its fibrous laminæ do not separate to form venous sinuses, as in the brain.

2. The *archnoid*, an exceedingly delicate membrane.

3. The *pia mater*; covers the entire surface of the cord and brain, and is a highly vascular structure.

The Spinal Cord.

The spinal cord is a flattened, cylindrical portion of nervous matter contained in the spinal canal. It is

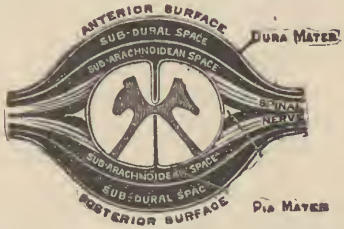


Fig. 39.—Transverse section of the spinal cord and its membranes.

about eighteen inches in length, and weighs about one and a half ounces. It is connected above with the

brain ; below it terminates in a slender filament of gray substance, called the *filum terminale*, which lies in the midst of many roots of nerves, called the *cauda equina*.

The Structure of the Spinal Cord.

The cord is composed of white and gray nervous substances, of which the gray is situated *internally*. The cord consists of two symmetrical halves, separ-

Fig. 40.—Transverse section of the spinal cord, showing its central mass of gray substance, and the roots of the spinal nerves.—*a*, *b*, spinal nerves of right and left sides; *d*, origin of anterior root; *e*, origin of posterior root; *c*, ganglion of posterior root.

ated by *fissures ;* the halves of the cord are divided again by other fissures. The gray matter is arranged in the shape of the capital letter "H," with the two uprights projecting outwards at both ends.

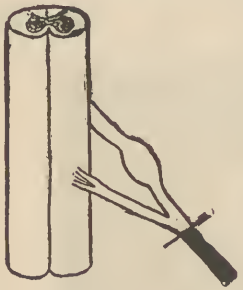
The Spinal Nerves.

They consist of thirty-one pairs, issuing from the sides of the whole length of the cord. Each nerve is made up of *two roots*, anterior and posterior ; the posterior root is peculiar in that it has a *ganglion* upon it. The anterior root is *motor*, the posterior root is *sensory ;* together they form a spinal nerve.

Effects of Division of the Spinal Nerve Roots.

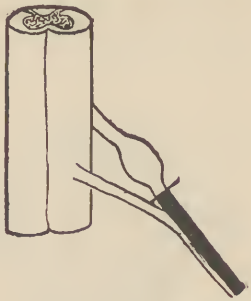
Division of the anterior root is followed by complete *loss of motion* in the parts supplied by the fibres of such roots; the sensation of the same part remains perfect.

Fig. 41.—Diagrams to illustrate Wallerian degeneration of nerve-roots.



Spinal nerve divided. Both motion and sensation lost in parts supplied by that nerve.

Anterior root divided. Loss of motion in parts supplied by that nerve.



Posterior root divided. Loss of sensation in part supplied by that nerve.

Division of the posterior root is followed by complete *loss of sensibility* in the parts supplied by the fibres of such roots, while motion remains unimpaired.

Division of both roots, or of the nerve made up by such roots, results in complete loss of both motion and sensation ; in other words, in complete *paralysis.*

Function of the Spinal Cord.

1. *Conduction.* There is no way by which nerve impulses can be conducted to the brain from the trunk and extremities, or *vice versa*, other than that formed by the spinal cord. Sensory impressions are carried *up*, and motor impressions are carried *down* the cord.

Paraplegia is a paralysis of the lower half of the body ; in this condition disease has completely destroyed the thickness of the cord.

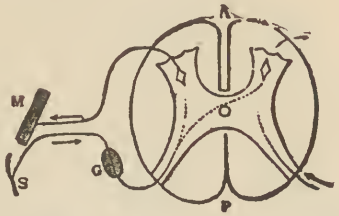


Fig. 42.—Diagram showing a reflex arc.—S, Skin; M, muscle; A-P, spinal cord; arrow showing direction of current.

Hemiplegia is a paralysis of one lateral half of the body.

2. *Reflex action.* Decapitate a frog. If the skin of one of the feet be irritated, the leg is immediately drawn up toward the body, as if to escape the source of irritation ; this is reflex action.

In order that reflex action may take place the following things are necessary :

(*a*) One or more afferent fibres to convey an impression.

(*b*) A nervous center for its reception, and by which it may be reflected.

(*c*) One or more efferent nerve-fibres, along which the impression may be conducted to

(*d*) The muscular or other tissue, by which the effect is manifested. In the absence of any one of these conditions reflex action cannot take place.

The Brain.

The brain comprises all that portion of the cerebro-spinal axis that is contained within the cavity of the cranium.

Fig. 43.—The brain inclosed in its membranes, and the skull.

a, *b*, *c*, convolutions of the cerebrum; *d*, the cerebellum; *e*, medulla oblongata; *f*, upper end of the spinal cord; *g*, pons Varolii; *h*, *i*, *k*, central parts.

Divisions of the Brain.

1. *The cerebrum;* forms the largest part that is contained within the cranial cavity.
2. *The cerebellum* (little-brain, or after-brain).
3. *The pons Varolii.*
4. *The medulla oblongata.*

The Cerebrum.

This forms the largest part of the brain. It consists of two halves, called *hemispheres*, separated

Fig. 44.—Upper surface of the cerebrum.

antero-posteriorly by a deep fissure, called the *longitudinal fissure* ; at the bottom of this fissure can be seen a strip of white matter, called the *corpus callosum*, which connects the two hemispheres together.

In the brain, the gray matter is external and is arranged into folds, which dip down into the brain substance, somewhat like the markings on an English

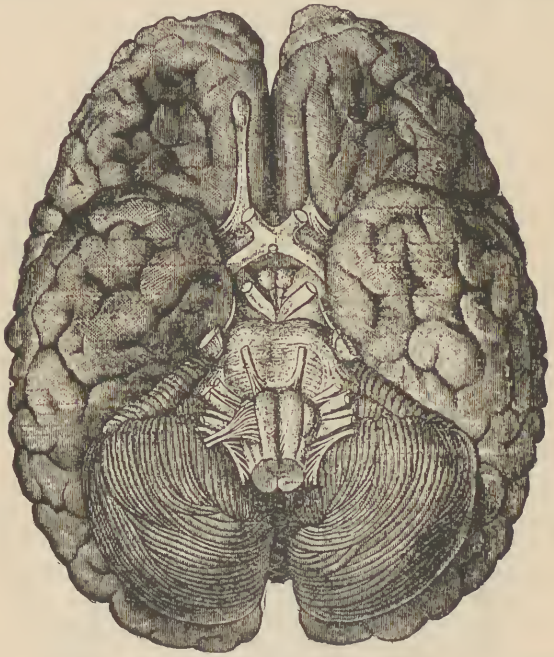


Fig. 45.—Under surface of brain, showing the cerebrum, cerebellum, pons Varolii, and medulla oblongata.

walnut. These folds are called *convolutions;* the fissures between these folds or convolutions are called *sulci.*

Function of the Cerebrum.

1. It is the organ of the will.

2. It retains impressions and reproduces them as ideas.

3. It is the medium of all the higher emotions and feelings, and of the faculties of judgment, understanding, memory, reflection, imagination, etc.

Effects of the Removal of the Cerebrum.

A pigeon from which the cerebrum has been taken will remain motionless and apparently unconscious unless disturbed. When disturbed in any way it soon

Fig. 46.—Pigeon, after removal of the cerebrum.

recovers its former position; when thrown into the air it flies. His eyes will follow a lighted candle, showing that he sees it. The discharge of a pistol behind the pigeon's back will cause him to open his eyes and turn his head partly around. These facts prove that he hears and sees and feels, but his reasoning power is gone.

The Cerebellum.

The cerebellum is situated beneath the cerebrum. It weighs about five ounces.

The Function of the Cerebellum.

Everything that is known with certainty regarding the function of the cerebellum indicates its close

connection with the power of co-ordination for the movements of the body and limbs.

Effects of the Removal of the Cerebellum.

If the cerebellum be removed from a pigeon, it sprawls about in a frantic way in its efforts to fly ; it seems to have lost the power of controlling its muscles.

Fig. 47.—Pigeon, after removal of the cerebellum.

The Pons Varolii.

The pons Varolii is the connecting bond between the cerebrum above, the medulla oblongata below and the cerebellum behind.

The Function of the Pons Varolii.

It transmits motor impulses and sensory impressions from and to the cerebrum.

The Medulla Oblongata.

Just after the spinal cord passes into the cranial vault it becomes enlarged ; this enlargement is called the *medulla oblongata*. It is pyramidal in shape with

its broad extremity upwards. It measures an inch in length, three-quarters of an inch in breadth, and one-half an inch in thickness. It is in the medulla that *decussation* of the fibres takes place, *i. e.*, pass from one side to the other.

Function of the Medulla Oblongata.

1. *Conduction.* As a conductor of impressions, the medulla oblongata has a wider extent of function than any other part of the nervous system, since it is obvious that all impressions passing to and from the brain must be transmitted through it.

2. *Reflex action.*

3. As a *special reflex center*, some of which are as follows: (*a*) Mastication; (*b*) Deglutition; (*c*) Sucking; (*d*) Vomiting; (*e*) Coughing; (*f*) Sneezing; (*g*) Respiratory; (*h*) Cardiac; (*i*) Vaso-motor, etc.

The Cranial Nerves.

These nerves are twenty-four in number, twelve on each side, emerging from the base of the brain. Two only of these will be referred to,—the fifth and the seventh.

The Fifth, or Trigeminal Nerve.

This is the nerve of sensation of the face. It emerges from the skull through three openings; being divided into three branches just before it reaches these openings. The first two branches are purely *sensory;* the third division is both *sensory* and *motor.*

The *sensory* branches supply the anterior and antero-lateral parts of the face and head; it is the sensory

nerve of the conjunctiva, of the teeth, and of the mucous membrane of the mouth, nose and tongue.

The *motor* branch supplies the muscles of mastication.

Fig. 48.—Diagram of the fifth nerve and its distribution.

The Seventh, or Facial Nerve.

This is the "nerve of expression"; that is, it is the *motor* nerve to the muscles of the face. It emerges from the skull just below the ear, and, passing through the parotid gland, is distributed to all the muscles of the face. If this nerve is paralyzed, the face on that side is smooth and expressionless; the eyes cannot be

closed, lip movements are interfered with, food collects between the teeth and gums, and the face is drawn toward the opposite side, producing much distortion of the features.

Fig. 49.—Diagram of the seventh nerve and its distribution.

The Sympathetic System.

The sympathetic system consists of :

1. A series of ganglia, extending from the base of the skull, down in front of the bodies of the vertebral column ;

2. Of three great aggregations of nerves and ganglia, situated in front of the spine in the thoracic, abdominal (*solar plexus*) and pelvic cavities ;

3. Of smaller ganglia, situated in relation with the abdominal viscera ;

4. Of numerous nerve-fibres.

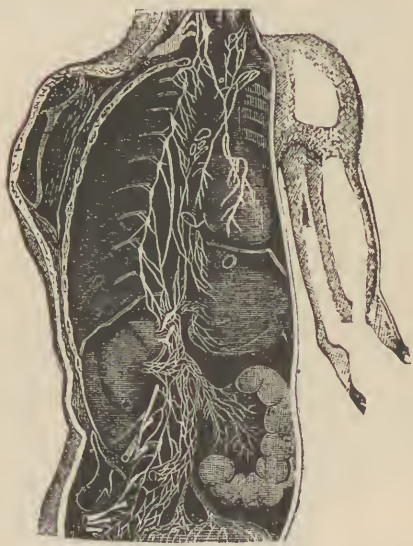


Fig. 50.—The sympathetic or ganglionic nervous system.

Functions of the Sympathetic Nervous System.

1. They supply the muscles of the vascular system, and so regulate the amount of blood to the part.

2. They supply visceral muscles ; so regulating peristalsis, etc.

3. They supply the secretory gland-cells ; so regulating the production of secretion.

From the above, it will be seen that the sympathetic nervous system has to do principally with *nutrition*.

Sleep.

All parts of the body that are the seat of active changes, require rest. The alternation of work and rest is necessary for the proper maintenance and healthy performance of their functions. To recover from fatigue, sleep is required. It has been shown, that if the blood of an animal, who has been thoroughly fatigued, be transfused into the blood of an animal *not* fatigued, the animal that has received the blood will exhibit all the signs and symptoms of fatigue. The inference is, that certain by-products of the tired animal have been transferred which are responsible for this action.

Loss of sleep is more damaging to the organism as a whole than starvation. It has been found that in young dogs, which can recover from starvation extending over twenty days, loss of sleep for five days or more was fatal.

X.—SPECIAL SENSES.

Sense of Vision.

The anatomy of the eye.—The eye-ball is contained in the cavity of the orbit. It is embedded in a mass of fat. It is composed of segments of two spheres of different sizes; the anterior is the smaller, and forms

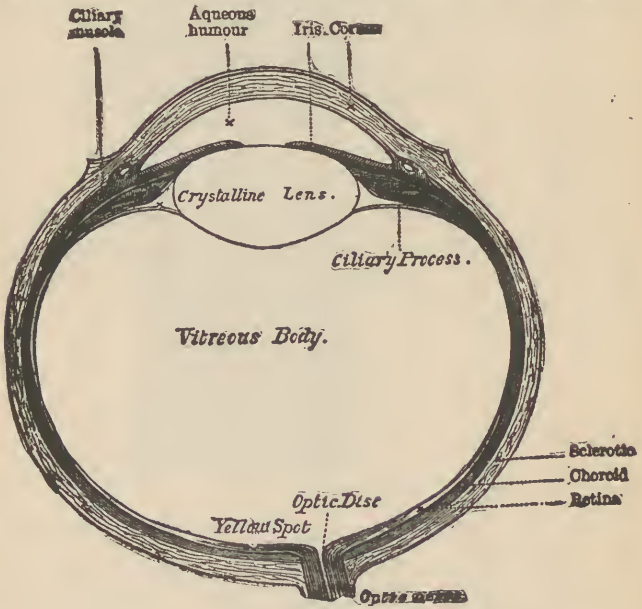


Fig. 51 —Horizontal section of the left eyeball.

about one-sixth of the eye-ball; the posterior is the larger segment, forming about five-sixths of the globe. The segment of the larger sphere is opaque; of the

smaller sphere, transparent. The axes of the eyeballs are directed outward.

The eyeball is composed of several investing tunics, and of fluid and solid refracting media, called *humors*.

The Tunics of the Eyeball.

1. Sclerotic and cornea.
2. Choroid, iris, and ciliary processes.
3. Retina.

The Refracting Media, or Humors.

1. Aqueous humor.
2. Crystalline (lens) and capsule.
3. Vitreous humor.

The Sclerotic Tunic.

This is a dense, firm, unyielding membrane, serving to maintain the shape of the globe, of which it forms the posterior five-sixths.

Its *function* is to protect the more delicate structures of the globe, and to give attachment to muscles which move the eyeball. A portion of the sclerotic coat can be seen forming the "white of the eye."

The Cornea.

This is the projecting, transparent part of the external tunic, and forms the anterior one-sixth of the globe. It is a dense and resisting structure.

Its *function* is to give shape to the organ and to protect the parts within.

The Choroid.

This coat lines the sclerotic covering, occupying the posterior five-sixths of the eyeball. It is a thin, highly vascular membrane.

Its *function* is to provide nourishment to the eye through its blood supply.

About the junction of the sclerotic coat and cornea, the choroidal coat greatly thickens, and here gives off the *ciliary processes.* These are from sixty to eighty in number. The anterior border of these processes are free and are situated behind the *iris.*

The Iris.

This corresponds to the diaphragm of an optical instrument, except that its orifice is capable of dilatation and contraction. It is a thin curtain situated behind the cornea and in front of the lens. It has a circular aperture called the *pupil.* The various *colors* which the iris assumes in different individuals depend upon the quantity and disposition of the *pigmentary granules.*

The *function* of the iris is to regulate the amount of light which enters the eye.

The Retina.

The retina is a delicate membrane upon the surface of which the images of external objects are received. Its outer surface is in contact with the choroid coat; behind it is continuous with the *optic* nerve. Exactly in the center of the retina, at a point corresponding to the axis of the eye, where vision is most distinct, is the *yellow spot.* Near this spot is the point of entrance of the optic nerve; here the power of vision is absent, so it is called the "blind spot," or *optic disc.*

If the left eye be covered and the right eye directed steadily at the white cross in Fig. 52 the circular pot will also be visible. Now if the page be moved

slowly backward and forward, a point will be found where the circular spot disappears from sight, because its image has fallen upon the "blind spot."

Anatomists divide the retina into nine distinct layers; the external layer is called that of *rods* and *cones*, and is the most important layer, being directly concerned in the reception of optical impressions. The number of optic nerve-fibres in the retina is estimated

Fig. 52.—Diagram for observing the situation of the blind spot.

to be about 800,000, and for each fibre there are about seven cones, one hundred rods, and seven pigment cells; out of these nerve vibrations the brain fashions the sensations of light, form and color.

The Aqueous Humor.

The aqueous humor is a colorless, transparent, watery fluid, filling the anterior portion of the eyeball (between the lens and the cornea).

Its *function* is to maintain the internal tension of the anterior parts of the eyeball, and to allow the changes of figure of the iris and lens, without affecting the external configuration of the cornea.

The Vitreous Humor.

The posterior or larger portion of the eyeball is filled with a semi-fluid substance, the *vitreous humor;* so called from its transparent and glassy appearance.

Its *function* is to support the retina and preserve the general spheroidal state of the eyeball.

The Crystalline Lens and Its Capsule.

The lens, enclosed in its capsule, is situated immediately behind the pupil, in front of the vitreous humor, and is surrounded by the ciliary processes.

The *lens* is a transparent, refractive body, circular in form, exceedingly elastic, made up of layers of fibres of different degrees of density; the whole is surrounded by the *capsule*. The diameters of the lens, in the adult, are about one-third of an inch transversely, and one-fourth of an inch antero-posteriorly. The arrangement of the fibres makes it possible to separate its substance into laminæ, which have been compared to the layers of an onion.

The *function* of the lens is to act as a strong magnifying glass, directing the rays of light in such a manner that they fall upon the retina properly.

The Appendages of the Eye.

The *eyebrows* surmount the upper circumference of the orbit, and support short, thick hairs.

Their *function* is to control, to a certain extent, the amount of light admitted to the eye.

The *eyelids* are movable folds placed in front of the eye.

Their *function* is to protect the eyes from injury.

The *eyelashes* are short, thick, curved hairs, attached to the edges of the eyelids.

Their *function* is to protect the eyes from dust and foreign bodies.

The *glands* of the eyelids are about thirty in number; their openings can be distinctly seen upon everting the eyelid.

Their *function* is to prevent adhesion of the lids by secretion.

The *lachrymal* gland is situated in a depression at the outer angle of the orbit; it is about the size and shape of an almond. Its *ducts* are about seven in number and open upon the upper lid.

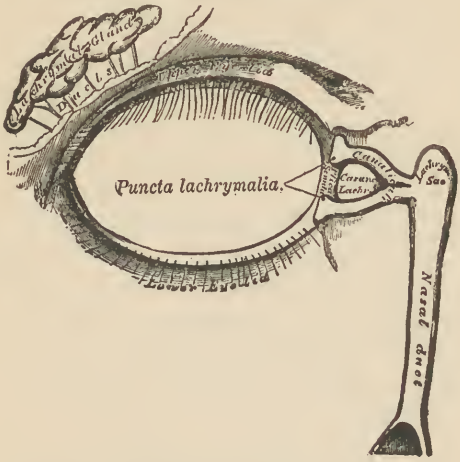


Fig. 53.—The lachrymal apparatus. Right side.

The *function* of the gland is to secrete a fluid, whose office is to keep the mucous membrane moist. Excess of this fluid constitutes the *tears*, which pour out over the cheeks.

The *lachrymal canals* have two openings at the inner side of the eye,—one in each eyelid; these two canals

empty into the *lachrymal sac*, which is the upper dilated extremity of the *nasal duct;* this nasal duct is a membranous canal, about three-quarters of an inch in length, extending from the lachrymal sac to the inner portion of the nose.

The *function* of the lachrymal apparatus is to moisten the mucous membrane and to keep it free from dust. Excess of tears are carried into the lachrymal ducts and then into the nasal duct and so is discharged into the nose.

The Optical Apparatus.

The optical apparatus consists of:

1. A system of transparent, refracting media and surfaces, by means of which images of external objects are brought to a focus upon the back of the eye.

2. A sensitive screen, the retina, which is the specialized termination of the optic nerve, capable of being stimulated by luminous objects, and of sending through the optic nerve such an impression as to produce in the brain visual sensations.

3. An apparatus for focussing at different distances from the eye, called *accommodation*.

4. An arrangement by which the eyes may be turned in the same direction by a system of muscles.

The Eye as a Camera.

The camera of the photographer consists of a box, blackened inside to absorb the light, with a lens in front to refract the rays from the object and bring them to a focus on the ground glass, where an inverted image of the object is clearly seen. The eye is a small, globular-shaped camera. The rays of light enter through a circular, transparent plate, the *cornea*,

which is set into the front of the eyeball like a watch glass over a dial plate. Behind the cornea is a colored curtain of muscular fibres, the *iris*, with a central aperture, the *pupil*, which becomes contracted or dilated by the action of the iris, according as the light is strong or weak. The *crystalline lens* of this natural camera, situated behind the iris, brings the rays to a focus on the *retina*, a delicate expansion of the nerve which carries the sensation of light to the brain. The whole is enclosed, except on the corneal front, in a strong casing of white, fibrous tissue which is the *sclerotic coat.*

The Function of Accommodation.

The eye is naturally set for the vision of distant objects, but nature has provided means for adapting it for vision at different distances. When a camera is out of focus the lens is moved forward or backward by a screw until the image is clearly outlined on the ground glass screen. In the eye, the action of the small muscle, the *ciliary muscle*, which is connected with the lens, increases the convexity of its anterior surface, which brings the rays from near objects to a focus on the retina. This is called the power of accommodation of the eye. As an optical instrument, the eye is far superior to the camera.

Refracting Media and Surfaces.

1. The anterior surface of the cornea.
2. The posterior surface of the cornea.
3. The aqueous humor.
4. The anterior surface of the lens.
5. The substance of the lens.
6. The posterior surface of the lens.
7. The vitreous humor.

Defects in the Refracting Media.

1. *Presbyopia.*

In elderly people the accommodation fails, owing apparently to a loss of elasticity of the lens; vision for distant objects remains normal, but that for near objects is impaired. This is corrected by *convex* glasses.

2. *Myopia.*

Here the objects are brought to a focus *before* they reach the retina, because the lens is too convex or the refracting media too powerful. This is called *short-sightedness* or *myopia.* This is corrected by *concave* glasses.

3. *Hypermetropia.*

If the lens is too flat or the refracting media too weak, the objects are brought to a focus *behind* the retina, and this is called *hypermetropia* or *long-sightedness.* This is corrected by *convex* glasses.

4. *Astigmatism.*

This is a condition in which there is a greater curvature of the cornea in one meridian than in another. This is corrected by the use of *cylindrical* glasses (*i. e.*, curved only in one direction).

Color Blindness.

Color blindness is the inability of certain areas of the retina to perceive those rays of light which normally fall on them, owing to the imperfect development of these areas. The common forms of blindness are for the red, green and yellow rays. This condition assumes greater importance when it is noted that these are the colors most used in signaling.

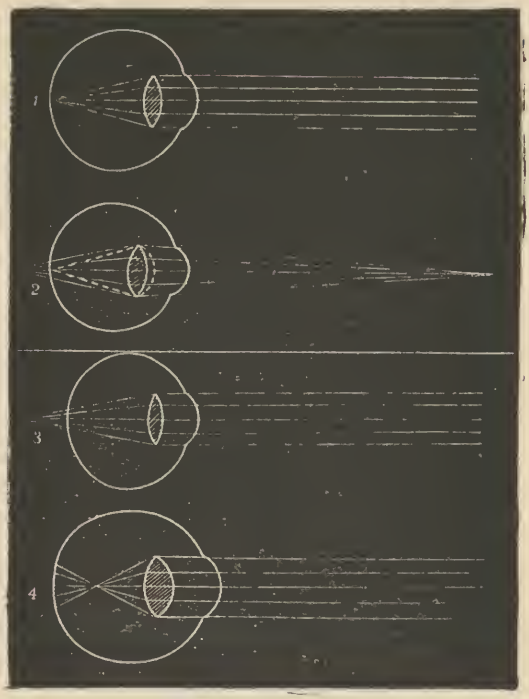


Fig. 54.—Diagram showing—1, normal (emme-tropic) eye bringing parallel rays exactly to a focus on the retina; 2, normal eye adapted to a near point; without accommodation the rays would be focussed behind the retina, but by increasing the curvature of the anterior surface of the lens (shown by a dotted line) the rays are focussed on the retina (as indicated by the meeting of the two dotted lines); 3, hypermetropic eye; in this case the axis of the eye is shorter, and the lens flatter, than normal; parallel rays are focussed behind the retina; 4, myopic eye; in this case the axis of the eye is abnormally long, and the lens too convex; parallel rays are focussed in front of the retina.

Care of the Eyes.

Eye-strain is a frequent cause of functional nervous

derangements. Hypermetropia is one of the most common causes of "sick head-ache."

Avoid doing anything that will produce a strain of the eye. If the eyes itch, or smart, or if sight be dimmed, or indistinct, consult an oculist at once. Do not attempt to "strengthen" the eyes by washing with cold water; it may produce ulcers on the cornea.

Fig. 55.—Section of the ear, showing the relative positions of the external, middle, and internal ear.

The Sense of Hearing.

Anatomy of the ear—function of its different parts.—The organ of hearing is divided into three parts, viz.:

1. *The external ear*, including the
   (*a*) *Pinna* or *auricle.*
   (*b*) *External auditory canal, or meatus.*
2. *The middle ear*, or *tympanum.*
3. *The internal ear*, or *labyrinth.*

The External Ear.

By external ear is meant the parts on the outer side of the *drum*, or *membrana tympani*, which include

the auricle and auditory canal, or meatus. The ear, so familiar to the sight, is a shell-like cartilage, supported upon the side of the head by ligaments, and having attached to it muscles which are rudimentary, but in certain individuals are still capable of performing that function which attains its perfection in the jack-rabbit.

The *external auditory canal* is about one and a quarter inches in length and is directed forward, upward and inward. At the external portion of the canal are the *ceruminous glands*, which secrete the *cerumen*, or *ear-wax*. The external portion consists of cartilage, and measures one-half an inch ; the inner portion consists of bone, and measures three-fourths of an inch.

The *function* of the pinna is to collect, and of the auditory canal is to transmit sound-waves to the tympanic membrane.

The Middle Ear, or Tympanum.

This is an irregular cavity, traversed by a chain of bones serving to connect the membrana tympani with the labyrinth.

The *membrana tympani* separates the middle from the external ear ; it resembles gold-beater's skin, and is made up of three layers, the outer *cutaneous*, the middle *fibrous*, and the inner *mucous membrane*, continuous with that lining the tympanic cavity.

The *function* of the membrana tympani is to receive the sound vibrations; it is then thrown into reciprocal vibrations which correspond in intensity and amplitude.

The Chain of Bones.

These bones form a chain, which extends across the tympanic cavity, forming an irregular line of

jointed levers, articulating with each other at their extremities; they are called the *malleus* (mallet), the *incus* (anvil), and the *stapes* (stirrup). The long handle of the malleus is inserted into the membrana tympani and its body is attached to the incus; and this, in turn, is joined to the stapes, which is set into an opening leading to the internal ear, where the essential organs of hearing are situated.

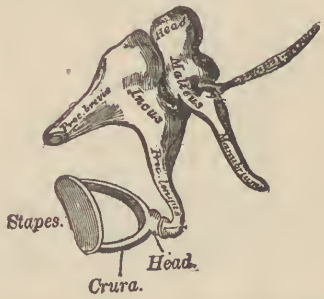


Fig. 56.—The small bones of the ear, seen from the outside.

The *function* of the ossicles (chain of bones) is to transmit the sound-waves across the tympanic cavity to the internal ear.

The Eustachian Tube.

Free communication is established between the middle ear and the pharynx by the Eustachian tube, which is about an inch and a half long. At the pharyngeal extremity it is cartilaginous; the rest of the tube is bony.

The *function* of the Eustachian tube is to maintain a free communication between the cavity of the middle ear and the naso-pharynx. The pressure within and without the middle ear is thus equalized.

The Internal Ear.

The internal ear is a complex system of circular and spiral tubular cavities drilled in the bone and filled with liquid, in which is suspended a membranous expansion of the nervous tissue by which the vibrations of the membranes on the inner wall of the tympanic cavity are conveyed to the brain as sensations of sound. The internal ear is exceedingly complicated and the function of its parts is but little known. The winding channels and spiral tubes are called *cochlia, semi-circular canals*, and the cavity is called the *vestibule*. The cavity of the vestibule is separated from that of the middle ear by a thin membrane, to which one of the bones of the middle ear is attached.

The *function* of the semi-circular canals appears to be to assist in maintaining the equilibrium of the body.

The *function* of the cochlia appears to be to appreciate the quality of pitch and the shades of different musical tones.

The external and middle ear contain *air*.

The internal ear contains a clear, limpid *fluid*.

Summary.

The waves of sound are gathered together by the pinna; they are conveyed to the membrana tympani through the external auditory canal; the membrana tympani is set in motion, and these vibrations are conducted across the tympanic cavity by the chain of bones to the opening in the intenal ear. The internal ear, receiving these vibrations, excites vibrations, in turn, in the fluid; this fluid is the medium which conducts the vibrations to the terminations of the auditory nerve, by which they are conveyed to the brain.

The Care of the Ears.

Pulling the ears is a piece of brutality that self-respecting parents should be ashamed to be guilty of. It may lead to deformities and also excite inflammations.

Boxing the ears is a dangerous procedure. Many a drum-head has been ruptured by the sudden driving in of a column of air upon its unprotected front.

Colds in the head affect the hearing in some degree, on account of the swelling of the membrane at the mouth of the tube. This inflammation may even travel up the tube to the middle ear, causing a permanent impairment of the sense of hearing.

The chief source of danger is, however, from the introduction of instruments of various sorts into the auditory canal, with the design of removing insects or foreign bodies; or with the design of scraping out the impacted wax. The membrana tympani is an exceedingly delicate structure and will not permit of meddlesome interference.

The Sense of Touch.

The sense of touch is subdivided as follows:

1. *Tatile sensibility;* by means of which we appreciate the slightest touch, and recognize the exact point at which the skin receives the impulse.

2. The *sense of pressure;* by which we are enabled to judge of the compression which is being made on a certain area.

3. The *sense of temperature;* by which we are enabled to judge whether an object is hot or cold.

Its Location and Organs.

1. *Touch corpuscles.*—These are situated in the papillæ of the true skin, and are found in the hands and feet, eyelids, lips, etc. They are oblong masses, about 1-290 of an inch in length, and 1-300 of an inch in breadth.

2. *End bulbs.*—These are situated in the conjunctiva, the lips, tongue, etc. They are about 1-600 of an inch in diameter.

3. *Pacinian corpuscles* are ovoid bodies situated in the subcutaneous tissue and not in the skin proper.

The Sense of Taste.

The sense of taste is localized mainly in the mucous membrane covering the superior surface of the tongue.

The tongue is a muscular organ, covered with mucous membrane, which is peculiar in that it contains *papillæ*, in the substance of which terminate the nerve filaments.

Taste beakers, supposed to be the true organs of taste, are ovoid bodies, about 1-300 of an inch in length, situated in the epithelium covering these papillæ.

Conditions necessary for the perception of taste are :

1. The presence of a nerve and nerve-center with special endowment.

2. The excitation of the nerve by sapid matters, which for this purpose must be in a *state of solution*.

3. A temperature of about 100 degrees Fahrenheit.

Primary taste sensations are four in number, namely, *bitter*, *sweet*, *sour* and *salt*.

Delicacy of the Sense of Taste.

Sulphate of quinine dissolved in the proportion of 1 to 33,000 gives a decidedly bitter taste, and a solution of 1 to 1,000,000 is, with difficulty, perceived as bitter. One can discern the taste of sulphuric acid in a solution of 1 to 1,000 of water.

The Sense of Smell.

The sense of smell is located in the mucous membrane lining the upper part of the nasal fossa, in which the olfactory nerves are distributed.

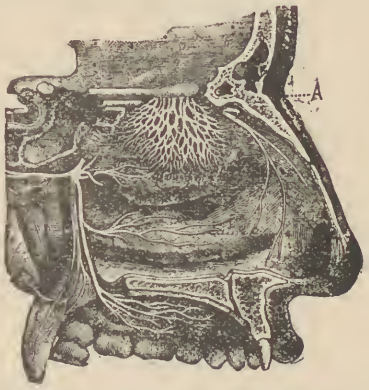


Fig. 57.—The interior of the left nasal passage.—A, the fan-like expansion of nervous fibres is the olfactory nerve.

The conditions necessary are:

1. Special nerve or nerve terminations in the form of special cells, stimulation of which cause the action of

2. Special nerve-centers capable of receiving impressions and transforming them into odorous sensations.

3. Emanations from bodies which are in a gaseous or vaporous condition.

4. The odorous bodies must be drawn into the nares freely in order to bring them in contact with the terminal filaments.

The Delicacy of the Sense of Smell.

This is most remarkable; the presence of bodies in quantities so minute as to be undiscoverable even by spectrum analysis can be discerned; 3-100,000,000 of a grain of musk can be distinctly detected.

XI.—VOICE AND SPEECH.

The Anatomy of the Larynx.

The larynx is the organ of speech, and is situated between the trachea and the base of the tongue. In the forepart of the neck it forms a considerable projection, called the *pomum Adami* (Adam's apple). It is composed of cartilages, united together by ligaments, and moved by muscles.

The cartilages of the larynx are nine in number, viz.:

Thyroid,	Two arytenoid,
Cricoid,	Two cornicula laryngis,
Epiglottis,	Two cuneiform.

The vocal cords are four ligamentous bands, extending across the larynx in an antero-posterior direction. The superior ones are called *false vocal cords*, because they are not directly concerned in the production of the voice. The *true vocal cords* are situated below the false ones; in between the true and false cords is a narrow fissure or chink, called the *rima glottidis*.

Voice.

Voice is produced by vibration of the true vocal cords, normally brought about by an expiratory blast of air passing between them while they are approximated and held in a state of tension by muscular action. The vocal cords are attached to the movable cartilages of the larynx; the muscles acting upon the cartilages can make the cords tense or lax. When the vocal cords are relaxed, nothing is heard except a faint whisper when air passes through the cavity of the

larynx. When the vocal sound is to be produced, however, the cords are made tense, and are applied

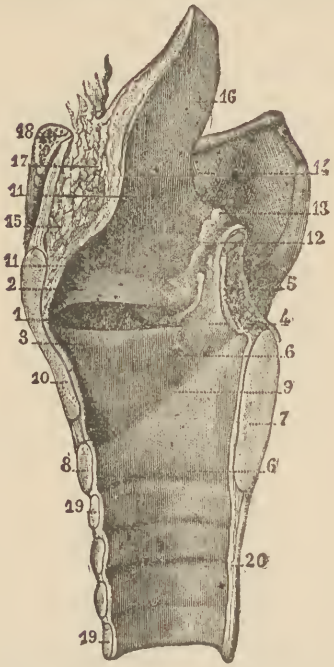


Fig. 58.—Longitudinal section of the human larynx, showing the vocal chords.

1, ventricle of the larynx; 2, superior vocal chord; 3, inferior vocal chord; 4, arytenoid muscle; 6, 6, inferior portion of the cavity of the larynx; 7, section of the posterior portion of the cricoid cartilage; 8, section of the anterior portion of the cricoid cartilage; 10, section of the thyroid cartilage; 11, 11, superior portion of the cavity of the larynx; 12, 13, arytenoid gland; 14, 16, epiglottis; 15, 17, adipose tissue; 18, section of the hyoid gland; 19, 19, 20, trachea.

closely to each other, thus diminishing considerably the diameter of the orifice; and the air, driven by

forcible expiration through the glottis, in passing between the vibrating vocal cords, is itself thrown into vibrations, which produce the sound required.

The vocal machinery consists of :

1. The motive power, or breath.

2. The larynx, which forms the tone.

3. The chest, the pharynx, the mouth, and the nose, which color the tone.

4. The organs of articulation.

Features of Voice.

The features of voice are :

1. *Loudness*, which depends upon two factors :
   (*a*) The strength of the tone-producing blast.
   (*b*) The resonance of the two chambers between which the vocal cords are suspended, the chest below, the cavities of the head above.

2. *Pitch*, which is determined by the thickness, tension, and length of the vocal cords.

3. *Quality*, which depends upon the size, form, and construction of the trachea, larynx, and the resonant cavities of the pharynx, nose, and throat.

The Change of Voice.

At the age of puberty a boy's larynx becomes congested and undergoes rapid development. The voice changes from the juvenile to the adult quality. During this change the voice frequently "breaks," or rapidly returns from the newly-acquired chest register to the head or falsetto tones of childhood.

XII.—STIMULANTS AND NARCOTICS.

Alcohol.

An alcohol is obtained by distillation from the fermented product of grape-sugar, which in the presence and growth of certain low organisms, as the yeast-plant, split up into alcohol and CO_2.

Various forms of Alcohol.

Rum	60 to 70	per cent.
Brandy	45 to 55	"
Whiskey	50 to 60	"
Gin	49 to 60	"
Port	20	"
Sherry	15 to 19	"
Burgundy	13 to 14	"
Claret	10 to 17	"
Champagne	6 to 13	"
Stout	6	"
Porter	4	"
Small beer	1	"
Teetotal drinks	6 to 14	"

Temporary Effects of Small Doses of Alcohol.

It stimulates the appetite and digestion, lessens the elimination of waste products, and causes a sensation of warmth. It increases the functional activity of all the organs.

Temporary Effects of Large Doses of Alcohol.

Large doses impair digestion; the heart's action is stimulated and the superficial blood-vessels are dilated. The imagination is excited, and the person loses his habitual timidity and self-consciousness. He may be making a fool of himself, but he is unconscious of it.

He may be in a maudlin condition, and he finds it difficult to articulate. He loses control of the motor nerves of locomotion and cannot walk steadily, if at all. He then may fall into a state of somnolence and insensibility, and later becomes a "dead drunk." He awakens later with symptoms of inflammation of the stomach, such as tenderness at the pit of this organ, nausea, retching, vomiting, coated tongue, intense thirst, impaired appetite, headache, etc.

Ultimate Effects of Alcohol Upon Organs and Tissue.

Alcohol, if habitually and excessively used, may cause disease of the kidneys, liver, stomach, lungs, heart, spleen, pancreas, and of the cerebro-spinal system of nerves. Alcohol, being a very diffusible substance, readily enters the circulation, and excites and over-stimulates all organs; the cells are affected and shrink, the connective tissues are increased in amount, and soon they contract, making certain organs harder, smaller, and sometimes nodulated. This is termed *cirrhosis*; occurring in the liver it has also had applied to it the name, "hob-nailed liver," "gin-drinker's liver," etc.

Chronic Alcoholism.

The effects of chronic alcoholism may thus be briefly summarized:

Nervous system.—Unsteadiness of the muscles, which is a constant feature. The mental processes are dulled. Irritability of temper, forgetfulness, and a change in the man's moral character are noted. It has been stated that more than seven per cent. of all cases of insanity are caused by alcohol alone.

Digestive system.—There is a furred tongue, appetite is impaired, and a sinking at the stomach which continues until the *habitué* has had his dram.

The small veins of the cheek and nose are dilated, and the nose becomes quite large. The eyes are watery.

Delirium Tremens.

This results from the long-continued use of alcohol acting on the brain. At the onset of the attack, the patient is depressed and restless and sleeps badly; soon delirium sets in. The patient talks constantly and incoherently; he is incessantly in motion. He sees objects in the room, such as rats, mice, snakes, and fancies they are crawling over his body. This terror is called popularly the "horrors." Sleeplessness is a constant feature.

Opium—Various Forms.

Laudanum.....Tincture of opium.
Sydenham's laudanum.....Wine of opium.
Black drop.....Vinegar of opium.
Paregoric.....Camphorated tincture of opium.
Morphine.....Alkaloid of opium.

Temporary Effects of Small Doses.

It exerts a quieting influence, inducing a peculiar dreamy condition, during which images and ideas float before the mind; time is shortened and seems to lose itself in rest. The mouth is dry and there is a slight perspiration noted. The after effects are headache, constipation, dry tongue and loss of appetite.

Temporary Effects of Large Doses.

The stage of excitement is brief and is followed by a profound sleep. There is a decided dryness of the

mouth and swallowing becomes quite difficult. Nausea and vomiting ensue. There is confusion of ideas, dizziness, contracted pupils, slow pulse, snoring respirations, sweating, etc. The after effects are headache, confusion of mind, dizziness, nausea, vomiting, and constipation.

Nicotine.

This is the alkaloid found in tobacco. The continued use of tobacco by smoking or chewing produces dyspepsia, sudden faints, nervous depression, cardiac irritability, and tends to hinder the higher development of the nervous centers; it impairs the nutrition of the body by interfering with the processes of digestion and assimilation.

Cocaine.

This is the active principle of coca. The leaves of coca were used by the aborigines long before their conquest by the Spaniards. They regarded them as "that heavenly plant which satisfies the hunger, strengthens the weak, and makes men forget their misfortunes."

Cocaine is a cerebral stimulant, producing peculiar mental excitement. Applied locally, cocaine acts as a very decided and certain anæsthetic.

Hashish.

This is an Arabian confection of *Cannabis Indica*, containing the leaves mixed with aromatics and various fruits.

This is employed chiefly for its intoxicating effects. When administered in full doses, it induces a feeling of exhilaration, attended by sensations which are, as a rule, pleasurable; beautiful visions float before the eyes, and there is a sense of ecstasy "which fills the

whole being with laughter." The sense of prolongation of time is very characteristic.

Bayard Taylor's description, in his "Pictures of Palestine," of the sensations he experienced from taking a dose experimentally, gives a good idea of the effects of the drug.

Caffein.

This is the alkaloid usually prepared from tea-leaves or from coffee. It acts as a stimulant to the higher centers. It produces heaviness of the head, flashes of light before the eyes, singing in the ears, loss of sleep, and, in large doses, delirium. In some, it produces a stimulating and refreshing effect; in others, it gives rise to a condition of wakefulness and anxiety.

Chloroform.

In the stomach chloroform produces a feeling of warmth, followed by coldness. When taken internally or by inhalation, one should not forget that chloroform is a powerful cardiac depressant, and sudden death is liable to follow its use. Some people inhale chloroform to produce sleep. This is very unwise, on account of the dangers attending its use.

Chloral.

This drug acts upon the cerebrum as a powerful and certain hypnotic. It is a cardiac depressant. The sleep produced by chloral is extraordinarily like that of nature, calm, dreamless and refreshing. There are no unpleasant after-effects from its use, as in the use of morphine.

Chloral Habit.

These subjects exhibit excited manners; they are voluble in speech, suffer from vertigo, wakefulness and

great depression of spirits. They have enfeebled mental powers, and they are really not responsible for their actions.

The Craving for Narcotics.

This is shared by all who become slaves to narcotics. The craving for alcohol or opiates is due to certain congenital or acquired morbid conditions, which render a minority of mankind peculiarly liable to the formation of these habits. The overpowering impulse or craving for excessive indulgence in inebriates, is not so much for the inebriating substance, which is often abhorred, as for the feeling of satisfaction afforded by the intoxicant. The majority of *habitués* first use the drug for the relief of pain, and then find themselves unable to break away from it. Life without the drug becomes unbearable. Anyone who has an intimate knowledge of the degradation to which these beings are reduced physically, mentally and morally, feels called on to raise a warning voice against the careless use of this class of drugs.

Hereditary Effects.

Alcoholism or narcomania are so frequently transmitted that all are agreed in considering their heredity as the rule. The passion for drink may not always be transmitted in that identical form ; it often degenerates into mania, idiocy, and hallucinations. Again, insanity in the parent may become alcoholism in the child. A frequent effect of these habits is partial or total atrophy of the brain ; the organ is reduced in size, so that it no longer fills the bony case. The consequence is a mental degeneration which in its progress results in lunatics and idiots.

XIII.—EMERGENCIES.

Hemorrhage.

Hemorrhage is the escape of blood from the heart or blood-vessels. There are three varieties, viz.:

1. *Arterial.*—This is characterized by bright-red blood spurting out in jets syncronously with the action of the heart.

2. *Venous.*—This is characterized by dark blood flowing uninterruptedly.

3. *Capillary.*—This is characterized by a constant oozing.

Temporary Control of Hemorrhage.

1. *Nature's method.*—When an artery is cut across, its muscular fibres *contract*, narrowing and even closing the orifice. At the same time the elasticity of the vessel causes it to *retract* within its sheath. These changes in the cut vessel—contraction and retraction—are followed by *coagulation of the blood*, which is the essential part of the process.

When a vein is cut across, its walls, being thin and inelastic, collapse, and so obstruct the current of blood, which favors coagulation.

2. *Pressure.*—This implies the use of the finger or thumb over the bleeding point, or over the vessel at some accessible place. If it is arterial hemorrhage, press the artery at some point between the wound and the heart; if venous, press the vein at the point below the wound. Greater force is required for the arterial than for the venous hemorrhage.

3. *Cold.*—This acts by causing contraction of the muscular coats of the vessels. Exposure of the bleeding part to the air operates in the same way.

4. *Heat.*—This acts in the same way as cold, causing contraction of the muscular coat.

5. *Styptics.*—These act by causing contraction of the artery, coagulation of the albumin, and the

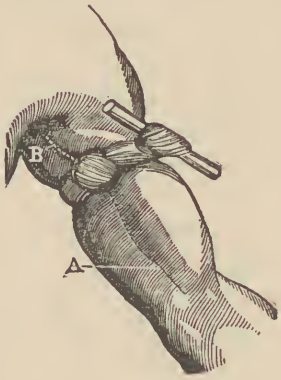


Fig. 59.—A B, the track of the large artery of the arm. The figure exhibits the method of applying the knotted handkerchief to make a compression on this artery.

separation of the fibrin, which is essential to the formation of the blood-clot. Chief among these are the persulphate of iron, powdered alum, tannin, nitrate of silver, vinegar, antipyrin in solution, etc. These should only be used where it is difficult to get near to the bleeding point.

6. *Forced flexion.*—This is applicable to the knee or elbow when the bleeding is from the femoral or brachial artery.

7. *Elevation.*—This applies to wounds of the veins

or capillaries of an extremity; elevating the limb may quickly stop the hemorrhage.

8. *Tourniquet.*—A handkerchief may be bound losely around the part and then tightly twisted with any kind of stick, umbrella, cane, etc. (See fig. 59.)

Asphyxia.

Death from suffocation, whether it be from strangulation, hanging, drowning, exposure to an atmosphere of coal gas, charcoal fumes, or the exhalations of pits, or mines, is due in each instance to the same cause—the deprivation of the system of oxygen, or *asphyxia*. Fresh air does not gain admittance to the lungs, venous blood remains venous blood, the blue blood shows through the skin, particularly where it is very thin, as in the lips.

The condition of the vascular system in asphyxia is:

1. More or less interference with the passage of blood through the pulmonary blood-vessels.

2. Accumulation of blood in the right side of the heart and in the systemic veins.

3. Circulation of impure (non-aërated) blood in all parts of the body

Therefore, in such instances, we must supply fresh air, get it to the lungs artificially, and stimulate the circulation.

Artificial Respiration.

Lay the patient upon his back with the shoulders elevated, the neck extended, and the head thrown back. Draw the tongue forward and remove foreign bodies from the pharnyx. Seize the forearms just

below the elbows and carry them over the patient's head as far as they will go ; this action expands the thorax, causing *inspiration*. Hold in that position for two

Fig. 60.—Sylvester's method. First movement (inspiration).

seconds, then bring the arms down to the sides of the thorax, pressing them against the ribs firmly for two seconds ; this contracts the chest, causing *expiration*. Repeat this process sixteen to eighteen times each

Fig. 61.—Sylvester's method. Second movement (expiration).

minute. This is called *Sylvester's method* of artificial respiration, and is one of the easiest of execution.

Treatment of a Drowned Person.

No time should be lost in removing the body from the water ; and, except in inclement weather, resusci-

tation should be attempted on the spot. The upper or body clothing should be removed, and, as the air-tubes are frequently choked with indrawn water, the patient should first be placed face downwards on the ground, and his body raised by the hands of the operator clasped underneath the abdomen to cause the intruded water to escape, partly by drainage and partly by the upward pressure on the lungs, occasioned by the constriction of the abdomen. The mouth and nostrils are then cleaned and artificial respiration instituted. Meanwhile, without interfering with this latter procedure, the lower garments may be removed and the surface dried and protected with blankets or other available material. Apply warmth and friction to the body, rubbing the extremities *towards* the body. So soon as the patient is able to swallow, give warm drinks, to which has been added a little brandy or whiskey.

Fainting.

When the supply of blood to the brain is insufficient for its nutrition, the person faints. The first element in the treatment is to lower the head, so as favor the flow of blood to the brain, and then to improve the action of the heart by the sudden application of cold to the chest or head, by the use of pungent inhalations, as ammonia, or by the employment of some stimulant.

Sun-stroke.

The usual form comes on, in this latitude, during exposure, with pain in the head, dizziness, oppression, and sometimes nausea and vomiting. The absence of perspiration in the presence of so great heat, is one of the most characteristic features. There is loss of consciousness and labored breathing.

Transport the patient to a cool place. Apply to the body and head cold, in the form of ice or ice-water. It is better to place the patient in a cold bath, or wrap him in a sheet kept wet by sprinkling with cold or ice-water.

Hysterical Fits.

These are marked by prolonged and uncontrollable laughing or crying. The best treatment is by the exercise of calmness and judgment on the part of the bystanders, sometimes taking no notice of the attack, or else by leaving the patient alone in the room. The important element in the treatment is moral control.

Epileptic Fits.

An attack of epilepsy consists of loss of consciousness and convulsions. The patient is suddenly seized, utters a sharp cry, falls forward on the face, and is then seized with spasms which contort the features and jerk the body and limbs with much violence.

In treating an epileptic subject, it is needful merely to prevent the patient from injuring himself during his convulsion; place a piece of wood between his teeth to protect his tongue and free the chest from constrictions.

Apoplexy.

Compression of the brain caused by a hemorrhage or an effusion which depends upon disease instead of an external violence is called *apoplexy*. The patient is unconscious, has a snoring respiration, accompanied by a puffing out of the lips in expiration. One side is often paralysed.

The treatment consists in loosening the clothing

about the neck and chest, applying cold to the head, which should be kept elevated ; apply hot mustard water to the feet.

Burns and Scalds.

Burns are the effects of dry heat ; *scalds* are caused by hot liquids or steam.

In slight or moderate burns or scalds nothing relieves the pain so well as wrapping the parts in cloths wet with a saturated solution of bicarbonate of sodium or ordinary "baking soda." The local treatment should aim at the exclusion of the air and the prevention of decomposition. Antiseptic dressings are indicated. It makes but little difference what local dressing is used provided the surface is thoroughly excluded from the air and the process of dressing is neatly and properly attended to.

Electrical Burns.

The passage of a powerful current of electricity through the body will cause a burn at the point of contact ; this is accompanied by a dangerous form of shock, or even death. The following immedate treatment should be instituted :

1. Release the patient from the current. If possible, the rescuer should be insolated ; this can be secured by the wearing of rubber gloves and rubber boots. Silk is a good insolater, as well as dry wood, folds of cotton, or wool, or paper. Do not take the risk of touching *both* hands at once to the live wire.

2. Treat the shock. Place the patient in a safe place, loosen his clothing, and give him plenty of

fresh air. Keep the body warm, and if breathing is feeble or suspended, employ artificial respiration.

3. Treat the burn. The same as for burns and scalds.

Lightning Stroke.

Here there may be great depression, or shock, or instant death.

Treatment is the same as that described above; namely, fresh air, rest, warmth to the body, stimulation, and, if necessary, artificial respiration.

Frost-Bites.

This term is used to designate the local effects of cold. Their immediate treatment is very important.

Do not apply heat too quickly. First rub the parts with snow or cold water. Keep the patient in a cold room. As he gradually recovers, apply dry friction and then bring him into a warmed room and give hot drinks.

Signs of a Fracture.

We know that a bone is broken because:

1. The limb is bent or shortened.

2. There is an unnatural degree of movement at the seat of fracture.

3. There is violent pain.

4. When the limb is moved, the broken ends of the bones may be felt grating against each other.

5. Deformity from swelling or displacements of fragments is present.

6. There is impairment or loss of function.

Temporary Treatment of Fractures.

In breaks, occurring in the bones of the lower extremity, the utmost care should be exercised to

prevent the broken ends of the bone tearing the surrounding tissues. Do not allow the patient to

Fig. 62.—Umbrella used as temporary splint in fracture of the leg.

make endeavors to rise. If it be necessary to at once move the patient, have one person whose *sole duty* will be to take charge of the injured limb only; this person

should stand at the outer side of the patient's limb, grasping it firmly above and below the point of injury, and raising it as one piece, at the same time using slight "extension." *Shortly, the form of the limb should, as far as possible, be steadily preserved.*

Upper limb fractures are more easily dealt with, and exactly the same rules apply when lifting is necessary.

Means of transport must often be found. Most patients can walk after fractures of the upper extremities, supporting the limb with the other hand, or using pocket-handkerchief slings, etc. But those with fractures of the lower extremities should be carried. If anything like a stretcher can be arranged, the broken limb should be fastened to the sound one with handkerchiefs, above and below the fracture, to prevent movement of the fragments. Temporary *splints* can be made from folded newspapers, corrugated paper, umbrella frames, barrel staves, straw bottle-cases, etc. These should be applied firmly, or they will be useless.

The indications for treatment in all fractures are:

1. To "set" the fracture. (Done by a surgeon only.)

2. To maintain the fragments in position.

Repair of Fractures.

At the end of the second week the ends of the fragments are found united by a new tissue, much as if they had been pressed into a mass of hot sealing wax. This new tissue is called *callus*. This callus is at first soft, translucent, red and vascular, gradually

becoming firmer; later, it becomes ossified, or made into bone.

Union between broken ends of bone begins in about ten days; firm union requires from three to six weeks.

Signs of a Dislocation.

1. Altered appearance of the joint—generally very apparent when one compares the corresponding joint on the opposite side.
2. The mobility of the joint is lessened.
3. Efforts to move the joint cause much pain.

Temporary Treatment of Dislocations.

To treat a dislocation it is needful to have an exact appreciation of the form and relations of the ends of the bones involved and of the muscles, which exercise the strongest influence in preventing the return of the displaced bone to its proper position. Therefore, no attempts should be made to replace the bone; this requires the services of a skilled surgeon. Dislocations require the same care as fractures, except that no splints are necessary, as a rule.

Sprains of Joints.

A sprain is a wrench or a twist of a joint, stretching or rupturing the ligaments.

Treatment of Sprains.

The treatment of an ordinary sprain consists in the employment of *rest*, the application of splints, the judicious use of cold, moderate pressure by means of bandages, etc.

Common Poisons and Simple Antidotes.

The following are the chief of these substances:

General Poisons.	*Irritant and Corrosive Poisons.*
1. Alcohol.	1. Carbolic, Oxalic, Sulphuric and other } acids.
1a. Ether.	
2. Kerosene oil.	
3. Opium.	2. Corrosive sublimate.
4. Strychnia.	3. Arsenic.
5. Belladonna.	4. Antimony.
6. Prussic acid.	5. Phosphorus.
7. Chloral.	6. Caustic alkalies.

Poisonous Foods.

Shell-fish. Mushrooms.

Treatment of Acute Alcoholism.

Evacuate the stomach by means of a strong mustard emetic (two teaspoonfuls of flour of mustard in half a teacupful of water). If the patient cannot swallow, use the stomach-pump. Apply warmth to the extremities and cold to the head. Acute alcoholism rarely requires any special measures, as the patient sleeps off the effects of the debauch. Washing out the stomach with two or three pints of warm water often has a wonderful sobering effect, as also has the administration of aromatic spirits of ammonia, well diluted (a teaspoonful to a teacupful of water).

Treatment of Ether Poisoning.

Its treatment does not differ from that for alcoholic poisoning.

Treatment of Kerosene Poisoning.

This form of poisoning is becoming quite common. Vomiting usually occurs spontaneously; if not, an emetic should be used, or else the stomach-pump.

Treatment of Opium Poisoning.

When opium is taken for suicidal purposes, laudanum is generally employed. Give, *as quickly as possible*, a strong mustard emetic. Emesis is difficult to produce, on account of the benumbing effect of the opium on the vomiting center in the medulla. If necessary, use the stomach-pump. The man who would use the stomach-pump in a case of poisoning by hypodermic injection of morphine (*i. e.*, injected under the skin by means of a sharp needle), would, by most people, be set down as an ignoramus; but he would be right, for it has been experimentally shown that, when the drug is administered subcutaneously, much of it is eliminated by the stomach; in fact, by repeatedly washing out the stomach, more than half the quantity injected may be recovered. Every effort must be made to keep the patient awake and conscious of the necessity of breathing until the poison has been eliminated. Smack his buttocks and his back; walk him, or lead him, or carry him about in the open air; shake him by the shoulders; pull his hair; tickle his nostrils; shout in his ear; plunge him into a warm bath, and then into a cold one, alternately; dash cold water on his head, face and neck; *keep him awake.* Give him strong, hot coffee. The main indications for treatment in opium poisoning are to:

1. Evacuate the stomach.
2. Maintain respiration.
3. Keep up the circulation.

Treatment of Strychnia Poisoning.

This drug is usually found in the different "vermin powders"; it is sometimes called "rat's-bane," from

its employment as a rat-poison. As the form in which the poison has been taken is a bulky one, a brisk emetic should be given, or the stomach-pump used. The danger is from death from exhaustion caused by the convulsions, or death from the intensity of the convulsions. Little else can be done until medical aid is summoned.

Treatment of Belladonna Poisoning.

The words *bella donna* are of Italian origin, and mean "beautiful lady." It is said the women were in the habit of using it to dilate their pupils, and so enhance their charms. Do not grow this drug—called the deadly nightshade—in your garden, because it is poisonous, and the berries are particularly attractive to the eye of the child. Give a mustard emetic, forcing it down the throat; tickle the throat with your finger or a feather; make him swallow a quantity of warm water, and employ emesis again. The great remedy is the emetic, which brings up the offending cause. Use the stomach-pump, if necessary. Dash cold water over his face and head, keeping it up until the effects of the poison have worn away. Administer strong coffee. Apply friction to the extremities. Artificial respiration may be necessary.

Treatment of Prussic Acid Poisoning.

The materials used for prussic acid poisoning are usually either impure bitter almond oil, or Scheel's acid, or some of the soluble cyanides used by photographers. The action of this acid is so intense that often death is almost instantaneous. Should there be time for attempts at restoration, an emetic or the stomach-pump should be used. Ammonia should be inhaled, and

stimulants given freely by the mouth. Alternate douching with cold and hot water, or artificial respiration should be employed. Treatment is rarely successful, but it should be directed to maintaining the respiration.

Treatment of Chloral Poisoning.

The same as given under opium poisoning.

Treatment of Carbolic, Sulphuric, Oxalic and Other Acid Poisoning.

The stomach-pump should not be used unless the acid has been in very weak solution. Dilute and neutralize the acid as soon as possible. Lime water, chalk and water, soap and water, ordinary washing soda, or the bicarbonates of soda or potash in solution are all useful alkalies. Remember that the "nearest remedy is the best."

Treatment of Carbolic Acid Poisoning.

Carbolic acid poisoning is now perhaps the commonest of all forms of poisoning. The sulphates of soda or magnesia, in half-ounce doses, in a tumblerful of warm water, should be given at once, and the stomach then washed out with warm water, or with the same solution. Induce vomiting, if possible, with mustard and water, or use the stomach-pump cautiously. Later on use barley water, olive oil, milk, white of an egg, etc. Treat the shock by warmth, friction, ammonia, etc.

Treatment of Oxalic Acid Poisoning.

Oxalic acid poisoning (salts of sorrel) is rather a common form of suicidal poisoning. Many cases of accidental poisoning have occurred on account of its resemblance to Epsom salts. To neutralize the acid,

use chalk, whiting, lime water, or magnesia. Treat the shock by stimulants as already given.

Treatment of Corrosive Sublimate Poisoning.

The white of eggs, or wheat flour beaten up with water and milk, are among the best antidotes. Encourage emesis by the employment of warm water or mustard and water. Stimulants should be used.

Treatment of Arsenical Poisoning.

Arsenic is not only used in the manufacture of wall-paper, but also in candies, candles, advertising and playing cards, carpets, ornaments for children's toys, rubber balls, dolls, hat-linings, etc. The "*aqua tofana*" used by Spara, who presided over a society whose diversion it was to poison their own and other women's husbands, contained arsenic.

Empty the stomach by means of the stomach-pump; encourage emesis. Then administer tablespoonful doses of freshly prepared hydrated iron every ten or fifteen minutes. Give him oil, eggs, or lime water. Stimulate; apply warmth to the extremities by means of hot bottles, flannels, friction, etc.

Treatment of Antimonial Poisoning.

The treatment is the same as under arsenical poisoning; but in addition, give strong tea or coffee.

Treatment of Phosphorus Poisoning.

This is usually taken in the form of pastes for rats, swallowing the heads of lucifer matches, etc.

Do not give oil, because phosphorus is soluble in it; treat as in the cases of other irritant poisons. Sulphate of copper is an emetic and the physiological antidote, and, therefore, should be used. To prevent subse-

quent changes in the liver, the French oil of turpentine in full repeated doses should be employed.

Treatment of Caustic Alkali Poisoning.

The question of the use of the stomach-pump must be decided by the amount of caustic destruction that is present. Weak acids, such as vinegar and water, should be given.

Treatment of Shell-fish Poisoning.

Give an emetic; follow this with full doses of castor oil. Administer stimulants to relieve the subsequent depression.

Treatment of Mushroom Poisoning.

Remove the poison from the alimentary tract as soon as possible, by means of emetics and cathartics. Stimulate the patient freely.

No unqualified person would be justifed in administering an antagonistic dose of a powerful drug on his own responsibility.

Loss of Consciousness.

The chief causes are:

1. Injuries to the brain, with or without fracture of the skull.

2. Diseases of the brain, apoplexy, epilepsy, etc.

3. Poisoning by narcotics, opium, morphine, alcohol, ether and chloroform, etc.

4. Fainting, paralysis of the heart through fright, pain, exhaustion, loss of blood, etc.

Rules for the Guidance of Non-Professional Men.

1. Obtain all information possible as to the cause of the accident, whether the injured person has had a fall or a blow, when wounded, or has been drinking.

2. Note the position of the body and its surroundings, as the case might possibly be brought before a magistrate, and a minute account of it be required.

3. Observe whether the breath smells of spirits.

4. Remove all tight clothing from about the neck.

5. Give free access to fresh air round the patient and send all useless bystanders away.

6. Place the body on the back, with the head low if the face is *pale*, as in fainting after great loss of blood. If the face, however, is *red*, the head must be raised. If vomiting takes place, turn the head to one side in order that the vomited matters may not be drawn into the lungs.

7. If the patient no longer breathes, which can be ascertained by holding a looking-glass, or flat piece of metal, or a feather before the mouth and nose, then we should have resource to artificial respiration.

8. *Send as quickly as possible for medical assistance.*

XIV.—CONTAGIOUS AND ZYMOTIC DISEASES.

These are terms used to designate certain diseases which are propagated by immediate contact, or through the intervention of some other medium, from the sick to the healthy. They include such diseases as small-pox, chicken-pox, measles, scarlet fever, diphtheria, whooping cough, etc.

The Cause of Contagious and Zymotic Diseases.

In the light of recent researches, the "germ theory of disease" has reached the stage of positive demonstration. This theory affirms that certain diseases are invariably associated with the growth and multiplication in the system of corresponding specific micro-organisms, and that these micro-organisms are the actual causes of the disease. Infection of the body is the only way in which infectious diseases can be caused. This infection may be by direct contact, or it may be carried by means of the air, clothing, water, food, etc.

Contributing causes to contagious and zymotic diseases are :

1. Want of cleanliness, from coming in contact with micro-organisms.

2. Indigestion and stomach disorders predispose to infection. As a rule, micro-organisms are killed by the healthy stomach.

3. All things that tend to lower the vitality of the individual, such as bad hygienic surroundings, poor ventilation, poor and insufficient food, sleeping in crowded rooms, etc., are all contributing causes.

The Prevention of Contagious and Zymotic Diseases.

Prevention may be produced by :

1. *Immunity.* It is a well-recognized fact in fermentation that after a time the process ceases, and the addition of more ferment is void of result. The same holds true in certain diseases ; thus, if a person recovers, the organisms disappear, and the injection of more of them produces no result ; in other words, immunity exists toward the disease. Blood protects itself from invading organisms. The white corpuscles are the valiant soldiers for defense. When the organism enters the blood the leucocyte (white corpuscle) attacks, eats and digests them. This process is called *phagocytosis.*

2. Personal cleanliness.

3. Correcting indigestion and digestive disorders.

4. Increasing the resisting powers of the patient to disease by attention to his surroundings.

5. If possible, removing him from the source of contagion. *Isolation.*

6. Disinfection : *i. e.*, the destruction of the specific infectious material which causes the disease.

Disinfectants—Their Use.

A disinfectant is an agent which kills or renders inert the specific virus of any infectious disease.

Among the best disinfectants are :

1. Destruction by fire.

2. Boiling in water for ten minutes.

3. Application of dry heat—230 degrees Fahrenheit—for two hours.

4. Chlorinated lime, two per cent. solution.

5. Solution of chlorinated soda, ten per cent. solution.

6. Solution of bichloride of mercury, 1–2,000.
7. Fumes of sulphur.
8. Solution of carbolic acid, five per cent.
9. Solution of copper sulphate, five per cent.
10. Solution of chloride of zinc, ten per cent.
11. Formaldehyde, in solution or gas.

Important Recent Discoveries.

They have already been treated of in the text. The germ theory of disease is probably one of the most important ones. To the microscope more than any one thing we owe the advances made in the study of contagious and zymotic diseases. Although this instrument was discovered about the latter part of the sixteenth century, it has been only within the last few years that important discoveries have been made through its use. Since then bacteriology has grown into huge proportions, and thousands of honest workers are yearly making valuable additions to this science.

XV.—SANITATION.

Hygienic Problems Relating to Water Supply.

Nearly two-thirds of the tissue of the human body consists of water. Inasmuch as this water is constantly being lost by evaporation from the skin, exhalation from the lungs, and excretions through various organs, it is evident that this loss must be constantly supplied if the functions of life are to be properly performed.

The following *qualities* are desirable in water for drinking purposes:

1. The water should be colorless, transparent, sufficiently aërated, of uniform temperature throughout the year, and without odor or decided taste.

2. The mineral constituents (magnesium and lime salts) should not be present in greater proportion than 4 to 6 parts per 100,000. More than this gives to water the quality known as "hardness."

3. There should be but little organic matter present, and no living or dead animal, or vegetable organisms.

4. The water should be entirely free from ammonia and nitrous acid, and should contain but small quantities of nitrates, chlorides, and sulphates. In respect of *wholesomeness*, *palatability*, and *general fitness* for drinking purposes, the following classification is good.

Wholesome.	1. Spring Water.	Very palatable.
	2. Deep-well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious.	4. Stored rain water.	
	5. Surface water from cultivated land.	
Dangerous.	6. River water to which sewage gains access.	Palatable.
	7. Shallow well water.	

Purification of Water.

Water may be purified :

1. By filtration.

2. By boiling and agitation.

3. By oxidizing agents, such as permanganate of potassium.

Among other purifying agents may be mentioned distillation, the exposure of water in minute divided currents to the air, the immersion of pieces of charcoal or of iron wire, and the effects of plants and fish. In store reservoirs, the presence of a moderate quantity of living plants exerts a decidedly purifying influence, while the destruction of fish has been followed by an excessive multiplication of the small crustacean animals on which the fish had lived, thereby rendering the water nauseous and impure. The remedy was found in re-stocking the reservoir with fish.

Hygienic Problems Relating to Drainage.

Provision must be made for the rapid and thorough removal of waste-water and the excrementitious substances from the house. For this purpose there are needed :

1. Water-closets and urinals, wash-basins and bath-tubs, and kitchen or slop-sinks.

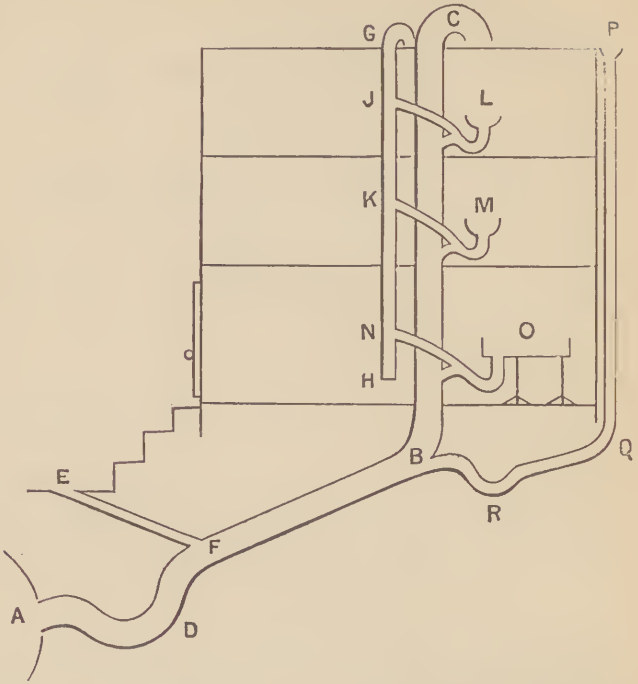


Fig. 63.—A is the sewer. A B C is the soil-pipe, opening on the roof at C and trapped at D. E F is the ventilating-pipe, communicating with the soil-pipe just behind D. G J K H is the ventilating-pipe to the traps, opening on the roof at G and giving off branches at J, K and N to the traps of the fixtures L, M, O, which branches are connected on the soil-pipe side of the traps as indicated. P R is the leader from the roof, connecting with the soil-pipe at B and trapped at R. The object of E F is to have a constant current of air blowing through the pipe. The air in B C, being within the house, becomes heated and escapes through C, while fresh air enters through E F. The object of G H and its branches, J, K, N, is to prevent siphoning of the traps by an action similar to that of the Sprengel air-pump.

2. A perpendicular pipe, with which the foregoing are connected, termed the soil-pipe.

3. A horizontal pipe, or house-drain, connecting with the common cess-pool or sewer.

In closets the chief points of leakage, and, therefore, of danger, are the horizontal pipes and the traps. In all cases the soil-pipe should be ventilated by a pipe carried to the open air at some point away from windows.

Hygienic Problems Relating to Heating.

The prevailing method of heating houses by means of hot air is objectionable, partly because the air is usually too dry to be comfortable to the respiratory passages, and partly because organic matter is frequently present in large proportions and gives the air an offensive odor. The first objection can be overcome, however, by keeping a vessel of water constantly in the furnace, so that the hot air can take up a sufficient amount of the vapor. Heating by hot water or steam is preferable to the hot air furnace. The details of the heating apparatus are usually left to individual taste.

Hygienic Problems Relating to Ventilation.

Natural ventilation is that which is carried on through the agency of natural forces. This includes:

1. *Diffusion*, which operates by equally distributing the products of respiration and combustion throughout the room. It does not remove the organic impurities, and, therefore, is inadequate as a ventilating power.

2. *Movements of air, produced by inequalities in temperature.* Air undergoes a certain increase or diminution in bulk, according as it is heated or cooled.

Warm air is lighter than cool air, and, therefore, there is a constant interchange going on where there is any difference between the outside and inside temperatures. If the air within and without a chimney were at the

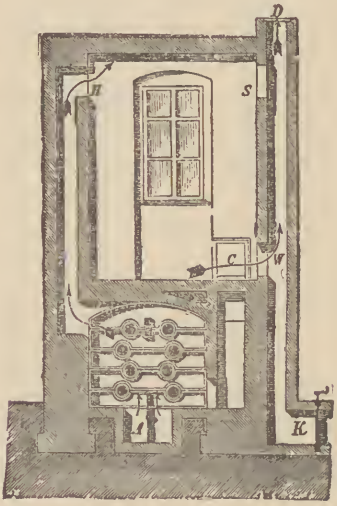


Fig. 64.—Diagram showing ventilation by furnace or air heated in the basement. A, cold air enters on heater; H, warm air enters the room; W, fouled air escapes into ventilating flue. (Buck.)

same temperature, it would be at perfect rest; but place a lighted candle at the bottom of the chimney, and so heat the column of air, and it will rise and cause cold air to rush in at the bottom.

3. *The action of winds.*

For rules for the arrangement of a system of natural ventilation, see page 76, under the heading "The Principles of Ventilation."

Artificial Ventilation.

This is carried on either by forcing the air into and through a room (*propulsion*), or by drawing the air out of the room (*extraction*).

The problem which the engineers have to solve in warming and ventilating our rooms is, What is the cheapest and most constant plan of introducing warm air of a temperature under 90 or 95 degrees Fahrenheit into our houses in cold weather, the conditions of the problem being a supply of 3,000 cubic feet per head per hour, at a rate of movement imperceptible to the feelings of the persons in the room?

The favorite system of ventilation, at the present day, is the combined system of warming and ventilation; the heat accomplishing the two important functions—that of supplying a proper temperature and fresh air.

QUESTIONS.

MINUTE STRUCTURE OF THE BODY.

Page xix.—Of what are the tissues and organs of the body composed? Of what does every cell consist? What is the nucleolus? What is protoplasm? What is its most striking characteristic? What do we mean by the motion of protoplasm?

Page xx.—What is "amaboid motion"? What do we mean by nutrition? What is a nucleus? What is its special function? What is intercellular substance? Why is it necessary?

Page xxi.—What is vital activity, or vital energy? What do we mean by the breaking down of the cell substance? Where does this take place?

I.—FRAMEWORK OF THE BODY.

Page 1.—How many bones are there in the entire skeleton? What are the functions of bones? How are bones classified? Of what does a long bone consist? What is the structure of the shaft? Of the extremities? Why are the extremities expanded? Where is the medullary canal? Name the important long bones. Where are short bones found? Give instances. Where are flat bones found? Give examples.

Page 2.—Give examples of irregular bones. What are the physical properties of bone? Of what does a section of bone consist? What is the periosteum? What is its function?

Page 3.—What is the marrow? What is the minute anatomy of bone? Describe an Haversian system.

Page 4.—What is the chemical composition of bone? What experiments will show this?

Page 5.—How does the chemical composition of bone vary with age? What is a "green-stick" fracture? What is "rickets" and its effect upon bones? What do we mean by ossification? When is it completed? What is the strength of bone?

Page 6.—What is the spine? What is a vertebra? How are the vertebræ arranged in the spine? What separates them? Why are we shorter at night than in the morning? How is the spinal canal formed? What does it contain? Name the curves of the spine and state their object. What is the skull? What arrangement of its bones serves the purpose of deadening shock? What movable bone has the skull?

Page 7.—What are the sutures of the skull? What are their functions? Name three principal sutures. What are the frontal sinuses?

Page 8.—How may the frontal sinuses cause headache? What is the thorax? Give its boundaries? What muscle forms its floor? What is its natural shape? What is the shape of a fashionably formed chest?

Page 9.—Describe the ribs. How many are there? What effect has inspiration on the diameters of the chest?

Page 10.—Name the bones of the upper extremity. Of the lower extremity. Give the number of bones in each. How are joints formed?

Page 11.—What are ligaments? What covers the surface of joints? What is a synovial membrane? What is its function?

Page 12.—Into what three classes are joints divided? Name three kinds of movable joints and give examples of each.

II.—MUSCLES.

Page 13.—What are the functions of muscles? What is muscular contractility? How many muscles are there? How many kinds of muscles are there? What is a voluntary muscle?

Page 14.—What is the structure of a voluntary muscle? What are striæ? Where are voluntary muscles found? Name the broadest muscle of the body. The longest. The smallest. What muscle separates the thorax from the abdominal cavity? What is an involuntary muscle? Where found? Describe its structure. What are tendons?

Page 15.—Where is the *tendo Achilles?* How can it be demonstrated? How do voluntary and involuntary muscles

differ in their action? What peculiarities has the heart muscle?

Page 16.—What stimuli may cause muscles to contract? Name the accompaniments of muscular contractions. How can we judge the muscular strength?

Page 17.—Compare the relative strength of horse and man. What is meant by the muscular sense? Upon what two sensations is the estimate of weight based? What experiment shows this? Why is exercise necessary?

Page 18.—What is the effect of exercise upon the body? What forms of exercise can you mention? What is the best exercise? What is fatigue?

Page 19.—What facts should be borne in mind regarding exercise?

III.—SKIN.

Page 20.—What is the general office of the skin? What is the structure of the skin? Of the epidermis? Of the derma? How thick is the skin? What are the papillæ?

Page 21.—What are the appendages of the skin? What are the hairs? Their function?

Page 22.—Describe a hair. What gives to hair its peculiar color? Describe the nails. Describe the sebaceous glands. What is the sebum? What is its function? Where are the sebaceous glands the most numerous? What are "blackheads"? What are the sudoriferous glands? What is their structure? How numerous are they? What is sweat? How much is excreted daily? What causes variations in the amount excreted?

Page 23.—What are the objects of bathing? What kinds of baths are there? What is the effect of a tepid, warm, or hot bath? What is the effect of a cold bath? What rules can you give as to the time for bathing?

Page 24.—When is the best time for the young and weak to bath? What symptoms occurring at the time of bathing should cause you to consult your medical adviser? What is the object of clothing? From what materials is clothing made? Why is cotton valuable in summer? Why is wool valuable in winter? What can you say about the color of clothing?

Page 25.—What can you say about the adaptation of clothing to the season of the year.

IV.—FOOD.

Page 26.—What is a food? Give a classification of foods. In what foods are the nitrogenous substances found? The non-nitrogenous substances? The inorganic substances? How would you classify the material found in a ham sandwich? Why do we need variety in our food?

Page 27.—How much of each kind of food is required daily according to Dalton's table? How is milk frequently adulterated? How can we distinguish adulterated milk? What is butter? Why is it of special value as a food? What can you say of the nutritive value of oleo-margarine? Why cannot cheese be eaten in large quantities? What can you say of the varieties of meats?

Page 28.—What is the most important source of proteids in the food? What can you say about the nutritive value of eggs? Is a hard-boiled egg hard to digest? From what flours is bread made? Why is flour made from the whole grain more nutritious than white flour? What do green vegetables contain? Fruits and fats? What is the most important of the inorganic foods? What proportion of the body is water? How much is needed daily? Is salt an essential food? Name a few other important inorganic substances.

Page 29.—What can you say of the decomposition and structural changes of the organic substances? What are the objects of cooking? What effect has suspended mineral matter on the digestive organs? What diseases may be caused by impure drinking water? What can you say of the effect of tea, coffee and chocolate upon the nervous system? If taken in excess? If taken in moderate quantities?

Page 30.—What is the effect of alcohol upon the digestion? Is alcohol a food? How do you explain it?

V.—DIGESTION.

Page 31.—What is the great design of food? What preparatory changes must food pass to accomplish this design? What is the object of each? What is digestion? Name the five stages of digestion. Name the digestive fluids. Where are they found?

Page 32.—What is the alimentary canal? How long is it? Of what is it composed?

Page 33.—What accessory organs has the alimentary canal?

Page 34.—Describe the mouth. Describe the structure of a tooth. How many sets of teeth have we? How many in the temporary set?

Page 35.—How many teeth in the permanent set? Give the names of the different teeth and the number of each in each set. What teeth have the characteristics of carnivora? Of herbivora? What causes decay in teeth?

Page 36.—What is Nature's defense for the teeth? What is tartar? What precautions are necessary to preserve the teeth? If decay be noted, what should we do? How many salivary glands are there? Describe the parotid gland. Name its duct. What is "*mumps?*"

Page 37.—Where is the submaxillary gland situated? Describe its duct. Describe the sublingual gland. How many ducts has it? What is the function of these glands?

Page 38.—Give the physical properties of the saliva. Name its ferment. What is the physical function of the saliva? Its chemical function? How much saliva is secreted in twenty-four hours? Into what stages is deglutition divided? Describe them. How long is the œsophagus? Name its coats. Describe the stomach. What is its capacity?

Page 39.—Where are its two openings, and what are they called? Describe the serous coat of the stomach. The muscular coat. The arrangement of the fibres.

Page 40.—Describe the mucous coat of the stomach. What is peculiar about it? What are these folds called?

Page 41.—Describe the movements of the stomach. What is the name given to these movements?

Page 42.—What is the function of the stomach? Describe the accident to St. Martin. What facts did Dr. Beaumont establish through his observations on St. Martin? What is the condition of the stomach when empty? When food is introduced? Describe the gastric juice. What two important constituents has it?

Page 43.—How much gastric juice is secreted in twenty-four hours? What are the physical functions of the gastric juice? The chemical functions? What is the average time for stomach digestion? What is chyme? How long is the

small intestine? Into what three portions is it divided? How long is the duodenum? The jejunum? The ileum?

Page 44.—Describe the structure of the small intestine. What forms the serous coat? Describe the arrangement of the muscular coat. What structures are found in the mucous coat?

Page 45.—Describe the *valvulæ conniventes*. What are their functions?

Page 46.—How long is the large intestine? Into what is it divided? What guards the opening between the cæcum and small intestines? Where is the vermiform appendix? How long is it? What forms the principal part of the large intestine? Through what does the rectum open externally? Describe the structure of the large intestines. Describe the liver. What are its functions? Where is the bile stored, and what causes its discharge into the intestine?

Page 47.—Describe the bile. What are its functions?

Page 48.—Describe the pancreas. Describe the pancreatic juice. What are its functions? What is an emulsion? What is the function of the intestinal juice? Describe the spleen.

Page 49.—What are the functions usually ascribed to the spleen? What movements occur in the intestines? What causes them? What is the object of these movements? Through what routes may absorption take place? Describe endosmose and exosmose.

Page 50.—Describe the lymphatic system. Describe the lymph. Into what does it empty? What are the villi?

Page 51.—How many villi are there? Describe a villus. What is the function of villi? Describe absorption by the villi. What is chyle? Describe the lymphatic system of the intestines. Describe the thoracic duct. Into what does it empty? Describe absorption by blood-vessels from the intestine.

Page 52.—What relation has the portal vein to absorption from the intestines?

Page 53.—What is lymph? Chyle? Is chyle found in the lacteals constantly? What gives chyle its characteristic appearance? What becomes of the waste in the intestines? What is the fæces? How much is discharged in twenty-four hours? What conditions influence digestion? Name a few sources of

digestive derangements. What retards or prevents digestion?

Page 54.—What is the result of over-eating? What aids digestion?

VI.—BLOOD.

Page 55.—What is the blood? What does it contain? What is the amount of blood in a human body? What is the color of the blood?

Page 56.—What is the taste of the blood? Its odor? Its reaction? Its specific gravity Its temperature? What are the functions of the blood?

Page 57.—What is the composition of the blood? What is the plasma? Describe the red blood-corpuscles. How do they appear under the microscope? What is their red color due to? What is their function?

Page 58.—What influences the combination of hæmoglobin with oxygen? Describe the white blood-corpuscle. What do you mean by "amaboid" changes? What is the relative proportion of the two kinds of corpuscles? What is the function of the white blood-corpuscles? Name one of the most striking properties of the blood. Of what does clot consist? What is serum?

Page 59.—How does serum differ from plasma?

VII.—CIRCULATION.

Page 60.—Of what does the circulatory apparatus consist? What is the function of each?

Page 61.—Describe the heart. What is the pericardium? What is the weight of the heart? Name the chambers of the heart. What chambers communicate?

Page 62.—Describe the systemic circulation. The pulmonic circulation. What is the use of the valves in the heart? Describe the course of the blood from one part of its course to another.

Page 63.—What is systole? Diastole? What sounds are heard over the heart? What causes them? What is the frequency of the heart's action? What are the arteries? What is the structure of an artery? What properties do arteries possess? What is the pulse? Describe it.

Page 64.—What are the veins? Their structure?

Page 65.—How does the internal coat of a vein differ from that of an artery? How are valves arranged? What are the capillaries? What causes the blood to circulate in the arteries? In the capillaries? In the veins? How rapid is the circulation in the arteries? In the capillaries? In the veins?

Page 66.—Describe the course of the blood from the right auricle, back to the same point. What part of this forms the systemic circulation? What the pulmonic circulation?

Page 67.—Describe the aorta. The femoral artery. The subclavian. The axillary. The brachial. The radial. The ulnar. The carotid. The vertebral. Describe the jugular vein.

Page 68.—Describe the inferior vena cava. The superior vena cava. The portal vein. The hepatic vein. Where does the blood from the digestive organs go before it enters the general circulation? Describe the sinuses of the dura mater. Do arteries always carry arterial blood? Do veins always carry venous blood? Describe the chemical changes that the blood undergoes during circulation.

Page 69.—With what does the oxygen unite? Where is the carbonic acid contained? What gives blood its arterial character? Its venous character? Give the relative proportions of oxygen and carbonic acid in the venous and arterial blood. What are the principal differences between arterial and venous blood?

VIII.—RESPIRATION.

Page 70.—What is respiration? Of what does the respiratory apparatus consist? Describe the nasal passages. What is the function of the hairs in the nose? Describe the mucous membrane of the respiratory tract. What is the function of cilia?

Page 71.—What are the functions of the nasal passages? Describe the trachea. Into what does the trachea divide? Where is the larynx? What is the general anatomy of the lungs? What is the pleura?

Page 72.—Into what are the lungs divided? Into what are the lobes divided?

Page 73.—Describe a pulmonary lobule. Describe a pulmonary vesicle. Where does the interchange between the air

and the blood take place? Of what does respiration consist?

Page 74.—Describe the thorax. What is inspiration? What is the name of the chief muscle of inspiration? What is expiration? Is it an active or a passive act? What is the breathing, or tidal air? Its average amount? What is the respiratory capacity? Its average amount? How often does a healthy adult respire each minute?

Page 75.—What is the composition of the atmospheric air by volume? What is the change in composition in the air that has been breathed? What changes occur in the blood as the result of respiration? How may air become impure?

Page 76.—What is *chlorophyll?* State the relation between plant respiration and animal respiration. State the principles of ventilation. How many cubic feet should be allowed in sleeping apartments for each person? Why? Does fatal results ever follow from overcrowding and poor ventilation? What occurred in the "Black Hole of Calcutta?" On the Irish steamer *Londonderry?*

Page 77.—Enumerate a few rules for a system of natural ventilation. What is animal heat? What is the normal temperature of man? Upon what does it depend? State a few circumstances that cause variations in temperature. What influence has age?

Page 78.—What influence has sex upon variations in temperature? Period of day? Exercise? Season? Food and drink? Disease? Baths? What can you say of the production of heat? Can oxidation occur without the production of heat? How are variations in the loss of heat regulated? What per cent. of the loss takes place from the skin?

Page 79.—What are the two principal sources of heat when one is exposed to great cold?

IX.—NERVOUS SYSTEM.

Page 80.—How is the nervous system divided? Of what does the cerebro-spinal system consist? What does it supply? What does the sympathetic system supply? Describe the general structure of the nervous system? What two main elements are found under the microscope? Name two varieties of nerve fibres. Where are they found? Describe a me-

dullated nerve fibre. What is the essential part of the fibre? What is the function of the white substance of Schwann?

Page 81.—What is the function of the neurolemma? Describe a non-medullated nerve fibre. What variety of nerve cells are there? What relation do the poles bear to the axis cylinder? Of what are nerve centers composed? What is their color? Their function? Of what are nerves composed? What is the function of nerves?

Page 82.—What parts compose the nervous system? An impression made upon a sensory nerve travels in what direction? If made upon a motor nerve? What may be caused by impressions made upon a centripetal nerve? Upon a centrifugal nerve? What relation do the centripetal and centrifugal nerve fibres bear to each other?

Page 83.—What do you mean by irritability or excitability of a nerve? Mention a few general stimuli. Mention a few special stimuli.

Page 84.—Of what does the cerebro-spinal system consist? What is the dura mater? In what particulars does the dura mater differ in the brain and cord? Describe the membranes of the brain and cord. What is the spinal cord?

Page 85.—What is the *filum terminale*? What is the *cauda equina*? What is the structure of the spinal cord? Where is the gray matter situated? What are the spinal nerves? What is peculiar with the posterior root?

Page 86.—What would be the effect of dividing the anterior root? The posterior root?

Page 87.—What would be the effect of dividing both roots? What is the function of the spinal cord? In what direction are sensory impressions carried? Motor impressions? What is reflex action? What things are necessary in order that a reflex action may take place? What do you mean by paraplegia? By hemiplegia?

Page 88.—What comprises the brain? Name the divisions of the brain.

Page 89.—What is the cerebrum? Where is the *corpus callosum?*

Page 90.—Where is the gray matter situated? What are convolutions? Sulci? What are the functions of the cerebrum?

Page 91.—What would be the effect of removing the cerebrum in a pigeon? What facts prove that the reasoning power is lost? What is the cerebellum? What is its function?

Page 92.—What would be the effect of removing the cerebellum in a pigeon? What is the pons Varolii? What is its function? What is the medulla oblongata?

Page 93.—What is the function of the medulla oblongata? What are the cranial nerves? What is the fifth or trigeminal nerve? What branches are sensory? What motor? What does each supply?

Page 94.—What is the seventh or facial nerve? If this nerve is paralyzed, what happens?

Page 95.—Of what does the sympathetic system consist?

Page 96.—Where is the solar plexus? What are the functions of the sympathetic system?

Page 97.—Why is sleep required? What can you say about the blood of an animal that is fatigued? Is loss of sleep more damaging to the organism than starvation? What experiment will prove this

X.—SPECIAL SENSES.

Page 98.—Give the anatomy of the eye.

Page 99.—Name the tunics of the eyeball. Name the refracting media of the eyeball. What is the sclerotic tunic? What is its function? What forms the "white of the eye"? What is the cornea What is its function? What is the choroid?

Page 100.—What is the function of the choroid? What are the ciliary processes? What is the iris? Where is the pupil? What is the function of the iris? What is the retina? What is the yellow spot? What is the "blind spot," or optic disc?

Page 101.—What experiment will prove the presence of the "blind spot"? How many layers has the retina? What is the most important of these? How many rods are there? What is the aqueous humor? What is its function?

Page 102.—What is the vitreous humor? Why is it so called? What is its function? What is the lens? What is its function? What are the eyebrows? What is their function?

What are the eyelids? What is their function? What are the eyelashes?

Page 103.—What is the function of the eyelashes? What are the glands of the eyelids? What is their function? What is the lachrymal gland? How many ducts has it? What is its function? How many openings has the lachrymal canal?

Page 104.—Into what do the openings of the lachrymal canal open? What is the nasal duct? What is the function of the lachrymal apparatus? What becomes of the excess of tears? Of what does the optical apparatus consist? Describe a photographic camera. Compare it with the eye.

Page 105.—What is the function of accommodation? What is the action of the ciliary muscle? Name the refracting media through which a ray of light passes.

Page 106.—What is presbyopia? How can it be corrected? What is myopia? How can it be corrected? What is hypermetropia? How can it be corrected? What do we mean by astigmatism? How can it be corrected? What is color blindness? What are the most common forms? What colors are most used in signaling?

Page 107.—What is eye-strain?

Page 108.—What is one of the most common causes of "sick headache"? How would you care for the eye? Why should we never wash the eyes in cold water? Describe the anatomy of the ear. Into what parts is the organ of hearing divided? What is meant by the external ear? Describe it.

Page 109.—What is the external auditory canal? What is the ear-wax? What is the function of the pinna? What is the middle ear? What is the membrana tympani? What is its function? What is the chain of bones?

Page 110.—Describe the relation of the bones to each other. What is their function? What is the Eustachian tube? What is its function?

Page 111.—What is the internal ear? What are the names of the winding channels and spiral tubes? What are their functions? What parts of the ear contain air? What part contains water? Describe how waves of sound are conveyed to the brain.

Page 112.—What is said of the care of the ears? What is the sense of touch? Into what is it subdivided?

Page 113.—What is the location of the sense of touch? What is the sense of taste? What is the tongue? What is peculiar about it? What are supposed to be the true organs of taste? What conditions are necessary for the perception of taste? Name the primary taste sensations.

Page 114.—How delicate is the sense of taste? What is the sense of smell? What conditions are necessary for the perception of the sense of smell?

Page 115.—How delicate is the sense of smell?

XI.—VOICE AND SPEECH.

Page 116.—What is the anatomy of the larynx? What is Adam's apple? Of what is it composed? Name the cartilages of the larynx. What are the vocal cords? What is the *rima glottidis*? What is voice? How is it produced?

Page 118.—Of what does the vocal machinery consist? What are the features of voice? Upon what do they depend? What is the change of voice?

XII.—STIMULANTS AND NARCOTICS.

Page 119.—What is an alcohol? Name the various forms of alcohol? What are the temporary effects of small doses of alcohol? What are the temporary effects of large doses of alcohol?

Page 120.—What do you mean by the expression "dead drunk"? What are the symptoms of inflammation of the stomach? What are the ultimate effects of alcohol upon the tissues? What is *cirrhosis?* What other names are given to cirrhosis of the liver? What are the effects of chronic alcoholism upon the nervous system?

Page 121.— hat are the effects of chronic alcoholism upon the digestive system? What is *delirium tremens?* What is a constant feature of *delirium tremens?* Name the various forms of opium. What is laudanum? What is Sydenham's laudanum? What is the black drop? What is paregoric? What is morphine? What are the temporary effects of small doses of opium? Name the after-effects. What are the temporary effects of large doses of opium?

Page 122.—Name the after-effects of large doses of opium? What is nicotine? What are the effects of the continued use of tobacco? What is cocaine? What is its local effect? What is hashish? What are the effects of full doses of hashish?

Page 123.—Name one characteristic effect of a full dose of hashish? Who gives a good description of the effects of hashish? What is caffein? Describe its effects. What is chloroform? What effect has it upon the heart? What is chloral? What is the chloral-habit? What can you say of those unfortunate people who have acquired this habit?

Page 124.—Why do certain people crave narcotics? How do people usually acquire this craving? Is alcoholism or narcomania hereditary? What is a very frequent effect of these habits?

XIII.—EMERGENCIES.

Page 125.—What is hemorrhage? How many varieties of hemorrhage are there? Name the characteristics of each variety of hemorrhage. Name the various methods for the temporary control of hemorrhage. What is Nature's method of controlling hemorrhage? What changes in the cut vessel are usually followed by coagulation? When an artery is cut what changes occur? When a vein is cut across what changes occur? Where do we apply pressure when an artery is cut? Where do we apply pressure in venous hemorrhage?

Page 126.—How does cold control hemorrhage? How does heat control hemorrhage? How do styptics control hemorrhage? Name a few styptics. When only should styptics be used? When is forced flexion applicable? When is elevation applicable?

Page 127.—Describe a tourniquet. What is asphyxia? What is the condition of the vascular system in asphyxia? What is artificial respiration? Describe Sylvester's method of artificial respiration.

Page 128.—What is the treatment of a drowned person?

Page 129.—How would you free the air-tubes from water? In applying friction to the body, in what direction would you rub? Why? What is fainting? How would you treat a fainting person? What is sun-stroke? What symptoms usher in

an attack of sunstroke? What is a characteristic feature of sun-stroke?

Page 130.—What treatment should you employ in sunstroke? What are hysterical fits? What is the best treatment of this condition? What are epileptic fits? Describe an attack of epilepsy. How should you treat an epileptic attack? What is apoplexy? Describe the patient's condition in an attack of apoplexy. Of what does the treatment consist?

Page 131.—What is a burn? What is a scald? What is the immediate treatment of burns and scalds? What is the object of local treatment? What are electrical burns? What immediate treatment should be instituted? How should the rescuer be insulated? Name a few good insulators. How should you treat the shock?

Page 132.—What is the treatment for lightning stroke? What is a frost-bite? Describe the immediate treatment. What signs would lead you to believe that a bone was broken? What is the temporary treatment of a fracture? What precautions should be taken in moving a person with a fractured bone?

Page 134.—What means of transport may be taken? What are temporary splints? What are the indications for treatment in all fractures? What can you say of the repair of fractures? What is *callus?*

Page 135.—When does union between the broken ends of bone begin? How long is required for firm union to occur? What are the signs of a dislocation? What is the temporary treatment of a dislocation? What is a sprain? What is the temporary treatment of a sprain?

Page 136.—Into what three classes are common poisons divided? Name a few general poisons. Name a few irritant and corrosive poisons. Name two poisonous foods. What is the treatment of acute alcoholism? How would you make a strong mustard emetic? What is the treatment of ether poisoning? What is the treatment of kerosene poisoning?

Page 137.—What is the treatment of opium poisoning? Why is emesis difficult to produce in opium poisoning? What is hypodermic injection? In case opium had been introduced into the system in this way would it be necessary to wash out the stomach? Why? What measures should be used to keep

the patient awake? What are the main indications in the treatment of opium poisoning? What is the treatment of strychnia poisoning? In what form is strychnia usually introduced?

Page 138.—In strychnia poisoning to what is death due? What is the origin of the term belladonna? What does the word mean? Why do women use it? Why should you not grow it in your gardens? What is the treatment of belladonna poisoning? What is the treatment of prussic acid poisoning?

Page 139.—Is the treatment of prussic acid poisoning usually successful? Why? What is the treatment for chloral poisoning? What are the general principles to be used in the treatment of poisoning by corrosive acids? Name a few useful alkalies that can be used. What is the treatment of carbolic acid poisoning? How would you treat the shock? What is the treatment of oxalic acid poisoning? Why have so many cases of accidental poisoning by oxalic acid occurred?

Page 140.—What is the treatment of corrosive acid poisoning? What is the treatment of arsenical poisoning? In the manufacture of what articles is arsenic used? What is the treatment of antimonial poisoning? What is the treatment of phosphorus poisoning? Why should you not give oil? Why should you use sulphate of copper as an emetic.

Page 141.—What is the treatment of caustic alkali poisoning? What is the treatment of shell-fish poisoning? Who only should administer an antagonistic dose of any powerful drug? What rules for the guidance of non-professional men can you give?

Page 142.—In what position should you place the patient if the face is pale? If the face is red? If vomiting occurs? How ascertain if the patient breathes?

XIV.—CONTAGIOUS AND ZYMOTIC DISEASES.

Page 143.—What are contagious and zymotic diseases? What diseases do they include? What can you say of the cause of contagious and zymotic diseases? What is the "germ theory of disease"? How may infection of the body occur? What are the contributing causes to contagious and zymotic diseases?

Page 144.—How may prevention of contagious and zymotic diseases be produced? What is immunity? What is phagocytosis? What is a disinfectant? Name a few of the best disinfectants?

Page 145.—What is one of the most important recent discoveries? To what do we owe the advances made in the study of contagious and zymotic diseases?

XV.—SANITATION.

Page 146.—How much of the tissues of the body consist of water? How is water lost from the body? What qualities of water are desirable for drinking purposes? What gives to water its "hardness"?

Page 147.—What waters are wholesome? Suspicious? Dangerous? Very palatable? Moderately palatable? Palatable? How may water be purified? What exerts a purifying influence in store reservoirs? What provisions are necessary for the removal of waste-water from houses?

Page 149.—What are the chief points of danger in closets? Why is hot air objectionable in heating houses? How can these objections be overcome? What is natural ventilation? What is diffusion? Why is it inadequate as a ventilating power? What does natural ventilation include?

Page 150.—What movements of air are produced by inequalities in temperature?

Page 151.—How is artificial ventilation carried on? What is propulsion? What is extraction? What problems have engineers to solve in warming and ventilating our rooms? What is the favorite system of ventilating at the present day? How is it accomplished?

GLOSSARY OF TECHNICAL WORDS AND TERMS.

Abdomen, the belly; being that one of the great visceral cavities which is bounded by the diaphragm above and the floor of the pelvis below.

Aborigines, the first inhabitants of a country.

Absorption, the process of sucking up fluids by means of an animal membrane.

Accessory, contributory.

Accommodation, the process by which the refracting condition of the eye is changed in accordance with the distance at which an object is to be viewed, so as to secure invariable focussing of the image on the retina.

Adam's apple, the prominence in the middle line of the throat.

Adulteration, the fraudulent addition of worthless or injurious material to a drug or an article of food or drink.

Agitate, to shake or stir.

Albumen, white of egg.

Albumin, a substance constituting the chief and characteristic constituent of albumen (white of egg).

Alcohol, a compound of a hydrocarbon radical with hydroxyl.

Alimentary, pertaining to alimentation.

Alimentation, a process or system of giving food; the processes of digesting and absorbing food.

Alkaloid, an organic substance possessing more or less alkalinity.

Amaboid, resembling an amœba in structure, form and behavior.

Amœba, masses of protoplasm characterized by a constant change in form.

Amphibia, a class of vertebrate animals distinguished by their existing in two separate stages of development—that of the larva, in which they are aquatic and breathe with gills, and that of the adult, in which they breathe with lungs; it includes toads, frogs and newts.

Amplitude, the distance from the crest to the trough of a wave.

Amyloid, starchy matter.

Amylopsin, one of the ferments of the pancreatic juice.

Anæsthesia, loss of feeling or perception.

Anatomy, the science which treats of the structure of organized bodies.

Animal heat, the heat developed by the processes of a living organism.

Antagonistic, acting against, opposed to.

Antidote, a remedial agent which counteracts the effects of a poison, or destroys the poison itself.

Antiseptic, preventing or checking putrefaction or septic infection.

Anus, the orifice at the end of the alimentary canal.

Aorta, the name of the artery that leads from the left ventricle.

Apoplexy, a stroke of paralysis.

Apparatus, a group of organs taking part in the performance of a common function.

Appendage, a dependent, supplementary or accessory structure.

Appropriation, the act or process by which an organism seizes upon foreign material and incorporates it with itself.

Approximated, placed close together.

Aqua fotana, a very active poison, consisting of a mixture of the arsenites.

Aqueous humor, the fluid which fills the anterior chamber of the eye; one of the transparent media lying between the lens and the retina.

Arachnoid, the middle one of the three membranes which invest the brain and spinal cord.

Aromatic, spicy, fragrant.

Arsenic, one of the elements; often used with suicidal intent.

Artery, the vessel that carries the blood away from the heart.

Articulation, a joint, whether movable or not; also, the utterance of syllables or words.

Artificial respiration, imitation of the natural movements of respiration.

Arytenoid, two cartilages of the larynx which rest upon the thyroid.

Asphyxia, a state of suspended animation, caused by impeded respiration.

Assimilation, the process by which the nutritive material is appropriated by the organism and becomes a part of it.

Astigmatism, a state of irregular refraction of the eye.

Atmosphere, the gaseous envelope surrounding the earth.

Atrophy, defective nutrition; a wasting of a tissue, an organ, a part or the whole body.

Auditory nerve, the special nerve of the sense of hearing.

Auricle, the upper chamber of the heart; the external ear. See pinna.

Axilla, the armpit.

Axis-cylinder, the essential part of the nerve-fibre.

Bacteria, a minute organism.

Beer, an alcoholic beverage made by infusing malt, with or without boiling, adding hops, and fermenting, with or without the addition of yeast.

Belladonna, deadly nightshade.

Bi-concave, concave on two opposite sides.

Bicuspid, double pointed, having two cusps.

Bile, the secretion of the liver.

Black drop, vinegar of opium.

Black-heads, hardened plugs of sebaceous matter contained within the cavity and ducts of the glands, seen more commonly upon the face.

Blind spot, the termination of the optic nerve as it pierces the eyeball.

Blood, the red fluid which circulates through the cavities of the heart, the arteries and the veins.

Brachial, pertaining to the arm.

Brain, all that part of the central nervous system that is contained within the skull.

Brandy, a spirituous liquor distilled from wine.

Breath, the air breathed, especially the expired air.

Breathing. See respiration.

Bronchi, the two primary branches of the trachea.

Burgundy, red or white wine from Burgundy, France.

Burn, an injury produced by fire or a very hot, dry object.

Butter, an aggregation of the globules of milk brought about by the agitation of churning.

Cæcum, the first portion of the large intestines; the blind gut.

Caffein, an alkaloid found in coffee, tea, etc.

Callus, the plastic material which is exuded between and around the ends of a fractured bone in the process of repair.

Canaliculi, minute canals in bone connecting the lacunæ with one another and with the Haversian systems.

Cancellous, resembling lattice-work.

Canine, resembling some structure of a dog, especially a dog's tooth.

Capillary, the vessel that intervenes between the arteries and the veins; hair-like in size.

Capsule, an enveloping structure containing a body distinct from itself.

Carbo-hydrates, a compound of carbon with oxygen and hydrogen, the latter elements being in the same proportion in which they unite to form water.

Carbolic acid, a substance employed as an antiseptic and disinfectant. Locally, it is a powerful irritant and anæsthetic; internally, in large quantities, it is a poison.

Carbonic acid, a gas formed when carbon is burned with an imperfect supply of oxygen.

Cardiac, pertaining to the heart.

Carotid, a term applied to the arteries on each side of the neck.

Carpus, the wrist.

Casein, a proteid substance occurring in milk.

Cauda equina ("horse's tail"), the termination of the spinal cord where it gives off many nerves.

Caustic, a substance that destroys the texture of organized bodies.

Cells, the elementary structure, anatomical unit, anatomical element, of which all animal and vegetable substances are constituted, or from which they develope.

Centrifugal, tending outward from a centre; efferent.

Centripetal, tending toward the centre; afferent.

Cerebellum, the little brain, situated at the lower and back part of the skull.

Cerebro-spinal, pertaining to both brain and spinal cord.

Cerebrum, the brain.

Cerumen, ear-wax.

Ceruminous glands, glands that secrete the cerumen.

Cervical, pertaining to the neck.

Champagne, a white wine made effervescent by being fermented in a bottle.

Change of voice, the harsh, shrill, irregular voice occurring in boys at puberty.

Charcoal, a substance produced from the slow combustion of certain animal and vegetable carbonaceous materials.

Cheese, the curd of milk, with or without the cream, salted and pressed into molds.

Chemical, pertaining to the science which treats of the composition of bodies and of the permanent changes of constitution which their mutual action produces.

Chest. See Thorax.

Chloral, a sleep-producing drug.

Chloroform, a powerful anæsthetic agent.

Chlorophyll, the green-coloring matter that exists in the leaves and other parts of plants.

Choroid, the middle coat of the posterior portion of the eye.

Chyle, the liquid found in the lymphatics of the small intestine (lacteals) during digestion, being the lymph of the intestine mixed with the fatty granules of emulsified alimentary material.

Chyme, a thick grayish or brownish liquid, consisting of the partly digested food as it is discharged from the stomach into the intestine.

Cilia, hair-like projections from free surfaces of ciliated cells which during life exhibit motion.

Ciliary muscle, the muscle that changes the outline of the lens.
Ciliary processes, folds or thickenings of the ciliary body.
Circulation, the motion of the blood through the vessels of the animal body.
Cirrhosis, a change in an organ characterized by an increase in the connective tissue elements and consequent shrinking.
Claret, a general term for the light-red wines of France.
Clot, a jelly-like mass formed by coagulation.
Coca, a tree found in South America.
Cocain, an alkaloid extracted from the leaves of the coca plant.
Cochlea, a conical cavity of the external ear.
Colon, that portion of the large intestines extending between the cæcum and the rectum.
Color blindness, a partial or complete incapacity of distinguishing colors.
Combustion, intense chemical change attended with the development of heat and light, and sometimes flame.
Compact, of close and solid texture.
Concave, hollowed out, having the centre more depressed than the edges.
Concentrically, having a common center.
Conduction, the property or process of giving passage to anything.
Conjunctiva, the thin mucous membrane covering the inner surface of the eyelids and part of the sclerotic coat.
Consciousness, the state of being able to take cognizance of impressions.
Contagious, susceptible of communication of disease from one individual to another by direct or mediate contact.
Convex, having a curved surface, the centre of which is more elevated than the edges.
Convolution, a coil or raised portion on the surface of the brain.
Convulsion, a paroxysm of involuntary and more or less violent muscular contractions, especially of the voluntary muscles.
Cornea, the anterior transparent segment of the outer coat of the eye.
Cornicula laryngis, two small cartilages of the larynx.
Corpus callosum, the white substance joining the two hemispheres of the brain.
Corpuscle, a general term for a cell.
Corrosive, having the power of corroding, eating away, of disorganizing a part.
Corrosive sublimate, bichloride of mercury, a corrosive poison.
Cranial, pertaining to the skull.
Cricoid, a ring-shaped cartilage of the larynx.
Crura cerebri, two thick bundles of white substance which extend from the upper border of the pons Varolii, diverging to enter the cerebral hemispheres.
Crustacean animals, animals having a crust-like shell with which the body and legs are covered, as the lobster.
Crystalline lens, a bi-convex transparent body lying behind the pupil.
Cuneiform, wedge-shaped.
Cuticle, a thin, dry, transparent membrane which covers all the surface of the body; the epidermis.
Cutis, the skin, especially the derma. q.v.
Cylinder, an elongated body of the same transverse diameter throughout and circular on transverse section.

Deadly nightshade, belladonna.
Death, the cessation of life.

Decay, a decline of the normal condition of a substance, especially putrefactive decomposition.

Decomposition, to putrefy.

Decussation, a crossing of structures in the form of the letter x.

Deglutition, the act of swallowing.

Delirium tremens, a condition due to an excess in the use of alcoholic liquors, and is the expression of their cumulative action.

Dentine, the principal part of the hard substance of the teeth.

Depressant, that which produces a sense of the reduction in strength or of hopefulness.

Derma, a dense, felt-like membranous layer situated beneath the epidermis.

Diaphragm, a musculi-tendinous partition between the thoracic and abdominal cavities.

Diastole, dilatation of the heart.

Diffusibility, the quality possessed by certain substances of being able to pass into the substance of another body so as so be brought into relation with every portion of it.

Diffusion, the process by which two liquids or two gases, when brought into contact with each other, gradually intermix until every part of one is in contact with some part of the other.

Digestion, the physical and chemical changes which nutrient material undergoes under the influence of digestive ferments to render it soluble, diffusible and assimilable.

Diosmose, the general phenomenon of endosmose and exosmose.

Disc, a roundish, plate-like structure.

Disease, abnormal performance of function by one or more organs or tissues.

Disinfectant, an agent used to disinfect.

Disinfection, the saturation of the atmosphere of a room with some material which deprives the organism of the ability of producing infection.

Dislocation, a displacement, especially of the articular surfaces of bones from their normal relations with each other

Distillation, the process of vaporizing a body by the application of heat, and of condensing and collecting the products.

Dorsal, pertaining to the dorsum, especially to the back of the trunk.

Drainage, the channel by which water or other liquid flows off.

Drum. See Membrana tympani.

Duct, a canal for conducting the secretion of a gland.

Dura mater, the tough external membrane of the brain and cord.

Duodenum, the first part of the small intestines.

Dyspepsia, a term usually denoting a chronic difficulty or painfulness of digestion.

Ear, the organ of hearing.

Effluvia, an invisible exhalation or emanation, especially one perceived by the sense of smell.

Eggs, a large nucleated cell which is capable of development into an organism similar to the parent.

Electricity, one of the forces of nature manifested in thunder and lightning, attraction and repulsion, etc.

Eliminate, to separate waste matters from the system.

Emergency, an unexpected event.

Emesis, vomiting.

Emetic, a substance that produces vomiting.

Emulsion, a milky fluid containing fatty matter in suspension in a state of very fine subdivision.

Enamel, a dense structure forming a protective covering for the crown of the teeth; it is the hardest structure found in vertebrates.

End-bulb, the expanded terminal portion of a sensitive nerve.

Endosmose, the flow of the liquid towards that which increases in volume.

Energy, the capacity for performing work.

Epileptic fit, the paroxysms of general convulsions occurring in an epileptic.

Epidermis. See Cuticle.

Epiglottis, a thin piece of cartilage placed behind the tongue, which is closed during deglutition.

Epilepsy, the falling sickness.

Epithelium, a covering for free surfaces, composed of cells joined at their edges and forming one or more complete layers.

Epsom salts, sulphate of magnesia.

Equilibrium, a condition in which contending forces are equal.

Essential, necessary, indispensable.

Ether, a volatile, transparent liquid much used in medicine and surgery.

Eustachian tube, the canal that connects the pharynx with the middle ear.

Evaporation, the act or process of converting from a solid or liquid state into a gaseous, by means of slow heat.

Exacerbation, a temporary aggravation of the symptoms of a disease.

Excitability, sensitiveness to stimulation.

Excrementitious substances, substances excreted and ejected; that which is discharged from the animal body after digestion.

Excretion, the separation from the economy of those things which are not necessary to it.

Exosmose, the flow of the liquid away from that which increases in volume.

Expansion, a spreading out; an increase in volume.

Expiration, the act of expelling the air from the lungs.

External auditory canal, the passage leading from the auricle to the drum membrane of the ear.

Extraction, the act of drawing out.

Eye-strain, throwing on the eye too great or too long-continued an amount of work.

Facial, pertaining to the face.

Fæces, the discharge from the bowels.

Fainting. See Syncope.

Fang, the root of a tooth.

Femoral, belonging to the thigh.

Ferment, an organic body, capable, in small quantities, of decomposing other organic bodies without yielding any of its own substance to the product of the fermentation.

Fibre, a filament, or a filamentous structure.

Fibril, one of the ultimate, fibre-like divisions composing a fibre; a very minute fibre.

Fibrin, a body obtainable from several of the natural fluids of the system by the process of coagulation.

Fibrous, containing or composed of fibres.

Filtration, the process of passing fluids through porous media to separate the insoluble suspended contents.

Filum terminale, a slender filament of gray substance at the end of the spinal cord.

Focus, the point at which rays of light are collected.

Follicle, a simple sacciform gland.

Food, any substance capable of nourishing or repairing the waste of the body.

Fracture, a solution of the continuity of an object, especially bone.

Frænum linguæ, a distinct fold of mucous membrane formed beneath the tongue.

Frost-bite, the effects of intense cold on living animal tissues.

Frontal, pertaining to, or situated on, the forehead.
Function, the special act, work or office of any organ.
Fusiform, spindle-shaped, tapering towards both ends.

Gall-bladder, a membranous reservoir containing the bile, situated on the lower surface of the right lobe of the liver.
Ganglion, an enlargement in the course of a nerve, resembling a knot.
Gastric, pertaining to or occurring in the stomach.
Gelatin, a proteid substance obtained by boiling hoofs, bones, cartilage, etc.
Germs, micro-organisms to which various infectious diseases are attributed.
Gin, an alcoholic beverage distilled generally from rye or barley and flavored with juniper-berries.
Gin-drinker's liver (cirrhosis of the liver). See Cirrhosis.
Gland, an organ which has the function of separating some particular substance from the blood.
Glossary, a dictionary or vocabulary of difficult, technical, or antiquated words or terms.
Glucose, a term applied to a group of sugars which are similar in chemical composition, and of which grape-sugar is the type.
Gluten, a proteid substance obtained by kneading wheat flour.
Glycogen, a secretion of the liver and other organs.
Granule, a small grain.
Gray fibres. See Non-medullated fibres.
Gustatory nerve, the special nerve of the sense of taste.

Hæmoglobin, a crystalline compound forming the principal part of the solid constituents of the red blood-corpuscles.
Hallucination, false perception without any material basis; formed entirely by the mind.
Hardness of water, the property in water due to the presence of lime salts chiefly, but to some extent to magnesia and iron.
Hashish, an Arabian confection of the leaves of *Cannabis Indica* mixed with aromatic and various fruits.
Heart, a hollow muscular organ, which propels the blood through the the vascular system.
Hemiplegia, motor paralysis of one lateral half of the body.
Hemisphere, half of a sphere.
Hemorrhage, an escape of blood from the heart or the blood-vessels.
Hepatic, pertaining to the liver.
Heredity, the inheritance of certain qualities or tendencies.
Hob-nailed liver (cirrhosis of the liver). See Cirrhosis.
Homogeneous, of the same kind or nature.
"Horrors." See Delirium Tremens.
Humor, any fluid of the body.
Hydrochloric acid, the ingredient which gives to the gastric juice its acidity.
Hygiene, the science of health.
Hypermetropia, far-sightedness.
Hypnotic, a drug that produces sleep.
Hypodermic injection, the introduction of remedial agents into the system by subcutaneous injection.
Hysteria, a functional affection of the nervous system.

Idiocy, congenital weak-mindedness.
Ileo-cæcal valve, situated at the junction of the small with the large intestine.
Ileum, the third part of the small intestine.
Immunity, the property which the organism may acquire of being safe from attacks of certain infectious diseases, either in consequence of a

former attack or from any other cause.

Incisor, a cutting instrument or organ.

Incorporate, to blend into a uniform mass.

Incus, an anvil; the second bone of the chain of ossicles of the middle ear.

Inebriates, a term applied to those who are habitually drunk.

Infection, the material by which communicable diseases are propagated.

Influx, a flowing into.

Ingestion, the act of introducing anything into the alimentary canal by the mouth.

Inorganic, not forming a part of an organic compound.

Insanity, a disease or disturbance of the brain characterized by a partial or complete derangement of the mental faculties.

Insolation, any form of prostration by extreme heat.

Inspiration, the act of drawing air into the lungs.

Instantaneously, in an instant.

Intensity, the state of being intense.

Intestine, the entrails; the bowels; the long membranous tube extending from the stomach to the anus.

Intoxicants, the drugs which when introduced into the system poison it, overwhelming the mental and bodily functions.

Involuntary, occurring independently of or against the will.

Iris, a thin, circular, contractile membrane, hanging vertically like a curtain in the anterior chamber of the eye.

Irritability, susceptibility to stimulation.

Isolation, the act or process of placing apart.

Jejunum, the second part of the small intestines.

Joint, an articulation, whether movable or not.

Jugular, pertaining to the throat.

Kerosene oil, an oil produced from petroleum.

Kidney, a gland for the excretion of the urine.

Labyrinth, the cavity of the internal ear.

Lachrymal gland, the gland that secretes the tears, situated in the upper and outer part of the orbit.

Lacteals, pertaining to or resembling milk.

Lacuna, spaces situated between the bony lamella and connected with one another by canaliculi; each lacuna contains a bone-cell.

Lamella, a thin plate.

Larynx, the organ of voice.

Laudanum, tincture of opium.

Leucocytes, white blood-corpuscles.

Ligaments, any strong, fibrous, compact tissue serving to bind or more or less closely connect one structure with another.

Light, the physical agency by which the external world is made manifest to the sense of sight.

Liquor sanguinis. See Plasma.

Liver, a glandular organ having for its chief function the secretion of bile and glycogen.

Lobes, a projecting and somewhat rounded portion of a part or organ.

Lobule, a small lobe.

Lubrication, the act of supplying an oily substance to a surface to render it smooth or slippery.

Lumbar, pertaining to the loins.

Lunatic, an insane person.

Lungs, the respiratory organ, serving for the aëration of the blood.

Lymph, a clear fluid found in the lymphatic vessels, derived largely from absorption within the different tissues, and finally poured into the great veins at the base of the neck.

Malleus, a hammer; the first of the chain of bones in the middle ear.

Mammalia, a class of vertebrates consisting of those that suckle their young.

Mania, a form of insanity.

Marrow, a soft reddish or yellowish substance filling the medullary cavities and canals of bones.

Mastication, the act of grinding solid food by means of the teeth.

Matrix, that which underlies the root of the nail.

Mechanical, caused or produced by machine-like forces or agencies.

Mechanism, the structure or arrangement of a machine.

Medulla oblongata (the "oblong marrow"), a part of the brain.

Medullary sheath. See White Substance of Schwann.

Medullated fibres, they form the white part of the brain and spinal cord and a large part of the cerebro-spinal nerves.

Membrana tympani, the drum membrane that separates the outer from the middle ear.

Membrane, a thin expansion of tissue.

Meridian, a great circle drawn from pole to pole on the surface of a spherical body.

Micro-organisms, a general term for microscopic organisms.

Microscope, an optical apparatus by which we may obtain a clear image of a near object, the image always being larger than the object.

Milk, a white opaque fluid secreted by the mammary glands.

Molar, having power to grind.

Morphine, an alkaloid of opium.

Motor, pertaining to or causing motion.

Morbid condition, a condition pertaining to, or affected with, disease.

Mouth, the ingestive aperture of the alimentary canal.

Mucous, having the qualities of, consisting of, or containing mucus.

Mucus, a clear, viscid secretion which lubricates mucous membranes

Muscles, the organs of motion in animals.

Muscular contractility, the property which muscles manifest of shortening upon the receipt of a stimulus.

Myopia, short-sightedness.

Myosin, a proteid substance found in muscle.

Mumps, an infectious and contagious disease, characterized by inflammation of the parotid gland.

Narcomania, a mania for narcotism of any kind.

Narcotic, an agent that produces stupor.

Nasal duct, the duct that conveys the tears from the lachrymal sac into the nose.

Naso-pharynx, the space between the nose and pharynx.

Nausea, sickness at the stomach with a desire to vomit.

Necrosis, death of a bone or part of a bone.

Nerve-centre, a central point of origin or termination for nerve-fibres.

Neurolemma, the delicate sheath that encloses a nerve-fibre.

Neutralize, to combine two bodies in such proportions that the compound will not exhibit the properties of either.

Nicotin, an alkaloid found in tobacco.

Nitrogenous, containing nitrogen.

Non-medullated fibres, the gray nerve fibres of the sympathetic system.

Non-nitrogenous, containing no nitrogen.

Normal, corresponding to the perfect type in all respects.

Nose, an organ serving for the passage of air in the function of respiration and phonation, for the distribution of the nerves of smell, and for conveying away superfluous seeretions from the eyes.

Nostrils, the external apertures of the nose.

Nourishment. See Nutriment.

Nucleus, the comparatively large body within and usually near the centre of any typieal eell and forming an integral part of it.

Nutriment, any substanee capable of nourishing or repairing the waste of the body.

Nutrition, the function possessed by living organisms of repairing waste tissue by the absorption and assimilation of alimentary materials.

Oculist, a person occupied ehiefly with the study and treatment of the eyes.

Œsophagus, the gullet; the tube extending between the pharynx and the cardiac end of the stomach.

Oleomargarine, artificial butter made from animal fat with the addition of some milk and other substances.

Olfactory nerve, the special nerve of the sense of smell.

Opium, a nareotic drug obtained from the poppy.

Optic nerve, the second of the cranial nerves; the special nerve of sight.

Organ, an individual part, or system of parts, of an organism, having a specific physiological function.

Organic, containing carbon or relating to bodies containing carbon.

Ossicles, small bones of the ear.

Ossification, the formation of bone.

Oxalic acid, a highly poisonous acid, appearing in the form of white or colorless crystals, which resemble Epsom salts, for which it has sometimes been mistaken with fatal results.

Oxygen, a non-metallic element.

Oxygenated, supplied with oxygen.

Oxy-hæmoglobin, hæmoglobin loosely combined with oxygen.

Pacinian corpuscles, bodies found especially in the skin of the hands and feet; they have to do with the sense of touch.

Pain, a local sensation of distress due to injury or disease.

Palatability, the quality of being agreeable to the taste.

Pancreas, a long, reddish gland situated behind the stomach; the sweetbread in the lower animals.

Papilla, any minute, soft or fleshy prominence or nipple-like projection.

Paralysis, the suspension or abolition of functional power, especially in the nervous system, in which case there is a temporary or permanent loss of motion, or of sensation, or of both.

Paraplegia, paralysis of both lower limbs.

Paregoric, camphorated tincture of opium.

Parotid gland, the large salivary gland situated near the ear.

Pathogenic, causing disease.

Pelvic, pertaining to or situated in the pelvis.

Pepsin, the main digestive principle of the gastric juice.

Peptone, the principal product of gastric and pancreatic digestion.

Pericardium, the sac that contains the heart.

Periosteum, a thin, delicate membrane forming the immediate covering of bones.

Peristalsis, a progressive vermicular and rhythmical motion of the intestines.

Peritoneum, a strong serous membrane investing the parietes and viscera of the abdomen; it is the

most extensive serous membrane in the body.

Perspiration, the fluid which escapes upon the surface of the body; the sweat.

Phagocytosis, the theory that regards the amaboid cells as scavengers, removing bacteria and minute solid masses that have accidentally reached the tissues.

Pharynx, the musculo-membranous sac at the back of the mouth and the upper part of the œsophagus.

Phenomenon, any occurrence or manifestation, especially one that is unusual or significant.

Photographer, one who produces pictorial representations of objects by throwing the rays of light from them on a chemically sensitive surface.

Physical, material, bodily.

Physiological, pertaining to the study of the functions of living animals.

Pigment, any coloring matter.

Pinna, the external ear.

Pia mater, the most delicate membrane of the brain and cord.

Plasma, that part of the blood in which the corpuscles float.

Pleura, the serous sac that invests a lung and lines one lateral half of the thoracic cavity.

Plexus, a complex or intricate collection of vessels or nerves.

Poison, any substance that acts upon the living organism in such a way as to destroy its life or decidedly impair its processes.

Pomum Adami, Adam's apple, q.v.

Pons Varolii, a division of the brain.

Port, a red, or sometimes a white wine, from Oporto, in Portugal.

Portal vein, the vein that collects the blood from nearly all the organs within the abdomen.

Porter, an infusion of malt and hops.

Predisposing, a condition which renders a person susceptible to disease.

Prehension, the act of grasping or taking hold.

Presbyopia, old sight, due to increased rigidity of the lens.

Propulsion, the act of driving forward.

Proteid, an amorphous non-crystallizable substance, containing carbon, hydrogen, nitrogen, oxygen and sulphur.

Protoplasm, a complex, jelly-like proteid living substance of animals and plants, which is capable of nutrition, growth, movement and reproduction.

Prussic acid, an extremely poisonous acid, whether taken by the mouth or the vapor inhaled.

Ptyalin, the ferment occurring in the saliva.

Pulmonary, pertaining to the lungs.

Pulse, a beat or throb; the movement of an artery, especially the perceptible impulse communicated to the contained column of blood by each beat of the heart.

Pupil, the circular aperture in the iris for the transmission of light.

Putrefaction, fermentative decomposition, attended with an offensive odor, due to the evolution of ammonia and sulphuretted hydrogen.

Pyloric, pertaining to the pylorus.

Pylorus, the opening of the stomach into the duodenum.

Radiation, divergence in ray-like lines from a central point.

Rat's bane, arsenious acid.

Reciprocal, mutually interchangeable.

Rectum, the last portion of the large intestine, terminating at the anus.

Reflex, caused by impulses conveyed by a sensory nerve to the central nervous system and thence reflected by a motor nerve to another part.

Reflex action, an action which takes place as the result of an impression made upon a sensory nerve, conveyed to the central nervous system, and thence reflected along a motor nerve to the part in which the action began.

Refracting, deflecting from a straight course.

Regurgitation, a flowing backward or reflux.

Rennen, a ferment found in the stomach which has the property of curdling milk.

Reservoir, a place where anything is kept in store.

Respiration, appropriation of oxygen by the tissues.

Respiratory capacity, the amount of air that can be forced from the lungs voluntarily after the fullest possible inspiration.

Retina, the innermost of the three coats of the eyeball; the sensitive coat of the eye.

Ribs, long, flat, curved bones that extend from the vertebral column.

Rickets, a constitutional disease of early childhood, characterized chiefly by curvature of the shafts of the long bones with thickening of their ends, and by deformities in other parts of the skeleton.

Rima glottidis, the opening of the glottis, or rather of the larynx.

Rivinian ducts, the ducts of the sublingual gland.

Rods and cones, this forms one of the most important layers of the retina; the number of cones has been estimated at 3,000,000.

Root, the portion of the nail that is covered by the skin.

Rudimentary, imperfectly developed.

Rugæ, the folds of the mucous membrane of a collapsed stomach.

Rum, an alcoholic liquor distilled from the residue obtained in the manufacture of molasses.

Saccharine, combined with or containing sugar.

Saliva, the fluid poured out into the cavity of the mouth; the spit.

Salivary glands, the glands that secrete the saliva.

"Salts of sorrel," the acid oxalate of potash.

Sarcolemma, a delicate elastic sheath entirely inclosing each individual striated muscular fibre, exclusive of the cardiac muscular fibre.

Sanitation, the enforcement of hygienic measures.

Saponification, the act or process of converting into soap; the decomposition of fats into fatty acids and glycerine by the addition of alkalies.

Scald, an injury produced by a very hot liquid or vapour.

Scheele's acid, a poison containing prussic acid.

Sclera, the posterior five-sixths of the external coat of the eye.

Sebaceous, pertaining to sebum.

Sebum, a fatty matter secreted by the sebaceous glands.

Secretion, the process by which certain constitutents are separated from the body by glands.

Segment, a part separated more or less completely from other parts.

Semi-circular canals, three canals found in the internal ear.

Sensibility, the power of feeling.

Sensory, concerned in sensation.

Serous, thin, watery, consisting of, containing, resembling, or producing serum.

Serum, the watery portion of an organic fluid (ordinarily of blood).

Shaft, the elongated central portion.

Sheath, an enveloping structure; a case or covering.

Shell-fish, a term applied to mussels, oysters, etc.

Sherry, a white or brown wine from the neighborhood of Xeres, in Spain.

Sínus, a cavity having a relatively narrow opening or entrance; a large venous canal.

Sinuses of the dura mater, venous channels found only in the interior of the skull, and formed by a separation of the layers of the dura mater.

Skeleton, a hard portion of the body designed for the support or protection of the soft parts.

Skull, the bony part of the head, which protects the brain.

Sleep, the natural condition of restful unconsciousness.

Smell, the perception of odor.

Soil-pipe, the vertical pipe connecting the water-closets and other fixtures with the house-drain.

Solar plexus, the largest plexus in the body, situated behind the stomach.

Sound, the sensation produced on the auditory-nerve filaments by the vibrations of a sonorous body.

Sound-waves, waves produced in air by a sonorous body.

Specific, peculiar to a certain substance.

Specific gravity, the comparative density of one body considered in relation to another assumed as the standard.

Speech, the faculty of articulate vocal utterance.

Spinal cord, all that part of the central nervous system that is contained within the vertebral canal.

Spine, the vertebral column.

Sphere, a solid that has all parts of its surface equidistant from the centre.

Spleen, a vascular organ lying between the stomach and diaphragm.

Splint, an apparatus composed of firm and hard material to be applied to an injured part to prevent displacement or motion.

Spontaneous, acting by its own impulse, energy, or natural law, without external force.

Sprain, the condition produced in the soft parts about a joint by a violent wrenching or straining of them without dislocation of their articular surfaces.

Spring-water, water as it issues from the earth.

Stapes, a stirrup; the third ossicle of the middle ear.

Stenson's duct, the duct of the parotid gland.

Sternum, the breast-bone.

Stimulant, an agent which incites or urges on to increased action.

Stomach, a dilatation of the alimentary canal between the œsophagus and the duodenum.

Stomach-pump, an instrument used to pump out the contents of the stomach.

Stout, a strong variety of porter.

Stria, a fine line.

Striated, striped, streaked, marked with striæ.

Strychnia, an alkaloid produced from the seeds of strychnos nux vomica.

Styptics, an agent which arrests hemorrhage by its local astringent action or by coagulating the blood.

Subclavian, situated beneath the clavicle (collar-bone).

Subcutaneous, situated immediately beneath the skin.

Sublingual gland, salivary gland situated beneath the tongue.

Submaxillary gland, salivary gland situated beneath the jaw.

Succus entericus, the intestinal juice.

Sudoriparus, producing or secreting sweat.

Suicide, one who takes his own life.

Sulcus, a fissure; especially of the cerebrum.

Sulphuric acid, oil of vitriol, a corrosive poison.

Sun-stroke. See Insolation.

Sydenham's laudanum, wine of opium.

Syncope, pallor and loss of consciousness from sudden weakness of the heart's action.
Synovia, the fluid which lubricates a joint.
System, a group or aggregation of organs or structures having special functions.
Systole, contraction of the heart.
Sweat. See Perspiration.

Tactile, pertaining to the sense of touch.
Tactile corpuscles, little bodies found in the papillæ of the skin.
Tarsus, the arch of the foot.
Tartar, foul matter which collects on the teeth.
Taste, the sensation of flavor.
Taste-beaker, patches of modified epithelia on the tongues of amphibia.
Tears, the liquid that is secreted by the lachrymal gland which moistens the eyeball.
Teeth, hard bone-like organs implanted in the jaws, which serve for the mastication of food.
Teetotaler, an abstainer.
Temperature, the degree of the heat of the body expressed in terms of some recognized standard.
Tetanus, an infectious disease characterized by tonic spasm of the muscles with marked exacerbations.
Thermal, pertaining to heat.
Thoracic duct, the principal trunk of the absorbent vessels, lying upon the dorsal vertebræ; it empties its contents into the left subclavian vein.
Thorax, the cavity bounded by the diaphragm below, the ribs and sternum in front, and the ribs and vertebral column behind, and closed in above by the structures in the lower part of the neck.
Throat, popularly the front of the neck.
Thyroid, the largest of the cartilages of the larynx.
Tidal air, the air that is habitually and almost uniformly changed in each act of breathing.
Tincture, a preparation made by dissolving a drug in alcohol.
Touch, the act or function of judging of the presence of external objects by means of direct contact.
Tourniquet, an instrument for making continuous pressure on a part.
Trachea, the windpipe.
Transpiration, perspiration, q. v.
Trigeminus, the fifth or largest of the cranial nerves.
Triturating, reducing a substance to a fine powder.
Trophic, pertaining to nutrition.
Trypsin, a ferment which may be separated from the pancreatic juice.
Tubular, hollow and nearly cylindrical.
Tunic, a coat; an investing membrane.
Tympanum, the cavity of the middle ear.

Ulcer, a superficial loss of substance with little or no tendency to heal.
Ultimate, remote.
Undulations, a wave-like motion.
Unstriated, not marked with striæ, unstriped.
Urea, the chief solid constituent of the urine.

Valve, a movable flap or fold which acts to close a passage or orifice more or less completely.
Vascular, richly supplied with blood-vessels.
Vein, the vessel that carries the blood to the heart.
Vesicle, a little sac or cyst.
Vestibule, a division of the internal ear.
Vena cava, the vein that returns the blood to the right auricle.
Ventilation, the act or process of supplying pure and fresh air.

Ventricle, the lower chamber of the heart.
Vermicular, worm-like in appearance or movement.
Vermiform appendix, an appendage of the cæcum; its function is unknown.
Vermin powders, powders used to destroy destructive animals, as rats, mice, etc.
Vertebra, one of the separate pieces which make up the spine.
Vertebral, pertaining to the vertebræ.
Vibration, the act or process of shaking or quivering.
Vice versa, the terms being exchanged.
Villi, minute finger-like or tongue-like processes projecting from the free surface of the mucous membrane of the small intestine; in these projections are the mouths of the absorbent vessels.
"Vis-a-tergo," the force from behind.
Viscera, the internal organs of the body.
Vision, the power of seeing; sight.
Vital, pertaining to life.
Vocal cords, antero-posterior folds on the internal surface of the larynx.
Voice, the utterance of articulate sounds.
Volume, bulk.
Voluntary, in accordance with or under the control of the will.

Well-water, water supplied partly by springs and partly by surface drainage.
Wharton's duct, the duct of the submaxillary gland.
Whiskey, an alcoholic beverage obtained by the distillation of an infusion of fermented grain.
White fibres. See Medullated fibres.
White substance of Schwann, a delicate sheath which envelopes the axis-cylinder.
Wholesomeness, the quality of contributing to health.
Wound, a division of the soft parts of the body by a mechanical force applied externally.

Yellow spot, the region of the centre of vision in the retina.

Zymotic, produced by micro-organism supposed to act as ferments.

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